RADIO and ELECTRICAL Review

TELEVISION - COMMUNICATIONS - SERVICE - SOUND

Incorporating "RADIO and ELECTRONICS"

NOVEMBER 1st 1954

VOL. 9, NO. 9

PRICE 1/10

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Radio and Electrical Review

OUR COVER:
Following on from the cover picture featured on our September, 1954, number, our cover picture this month shows the TV aerial equipment on the Casino roof at Cassel, used in the "Eurovision" experiment. An engineer is making adjustments to the 8-foot diameter diversity 2,000 mc/s. aerial, showing launching unit and feeder.

•

Official Journal of
The N.Z. Electronics Institute (Inc.).
The N.Z. Radio and Television Manufacturers' Federation.
The N.Z. Radio and Electrical Traders' Federation.
N.Z. Radio, TV and Electrical Assn. (Inc.)

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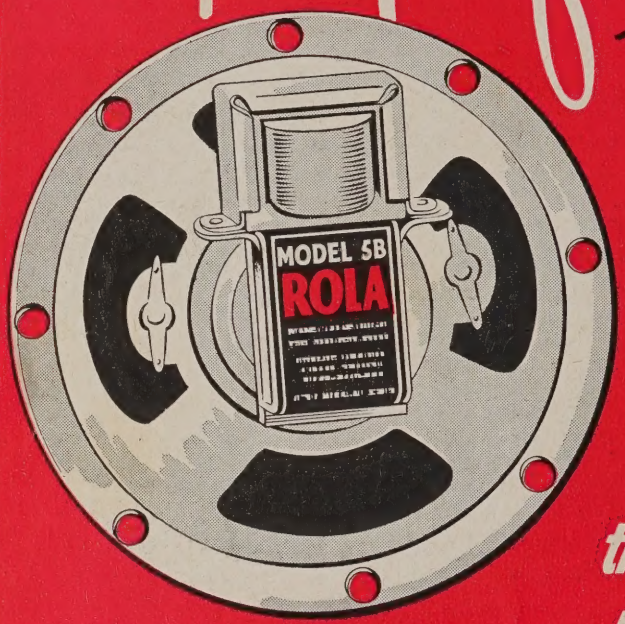

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Model 5B uses the famous Rola "Fluxmaster" principle of centre block construction and is designed to provide peak performance at minimum cost.

The diaphragm fitted to Model 5B has a fundamental resonance of 150 cycles per second ± 5 c.p.s., a value selected to give good bass response even when the loudspeaker is baffled only in a midget receiver cabinet. This fundamental resonance, together with a carefully engineered mid and high frequency response, combine to provide very pleasing reproduction through the full range of frequencies the speaker is likely to be called on to cover.

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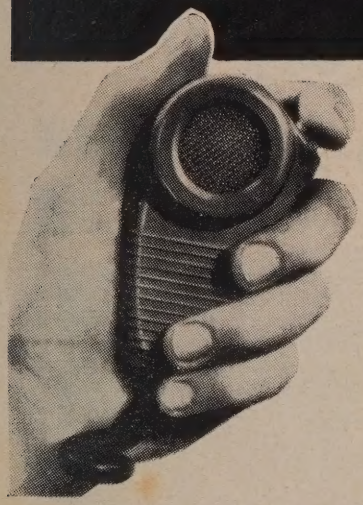
Power handling capacity	2½ watts
Diaphragm resonance	150 c.p.s.
Frequency response	145 c.p.s. — 6.5 K.c.
Voice Coil Impedance	3.5 ohms at 400 c.p.s.
Principal dimensions:	
Housing diameter	5"
Baffle opening diameter	4"
Voice coil diameter	5/8"
Depth front to rear	1-15/16"

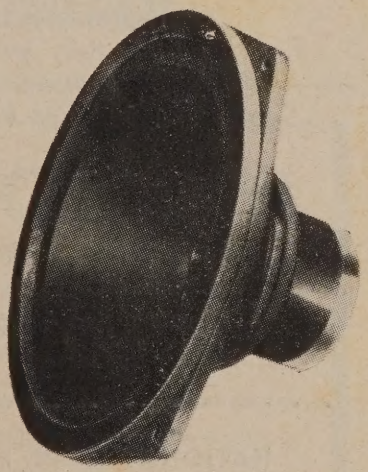
VITAVOX loudspeakers and microphones



THE WORLD'S FINEST PUBLIC ADDRESS EQUIPMENT

VITAVOX Equipment is first choice for Auditorium . . . Factory and Yard . . . Assembly Hall. Inbuilt quality of design, materials, and workmanship makes for VITAVOX superiority. There is a model for every sized installation, including radio gramophones and all sound work.

Space does not permit mention of full VITAVOX range. Please write for illustrated brochure, which gives fuller details.



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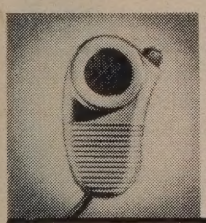


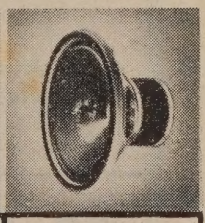
Type B.51 is a Piezo Crystal Microphone with a choice of four different "press-to-talk" switching arrangements or without switch.

Type B.52 Microphone incorporates matching transformer in place of switch and connects to grid or medium impedance lines.

Type "A" Dynamic Microphones have for some time, been the favourite instrument for high grade sound reinforcement

The GP.1 Pressure Unit is of minimum size and weight consistent with a high standard of performance and reliability.

A wide range of horns includes Multicell, Car Mounting and Circular Exponential types designed to give maximum efficiency.



K12/10 and K12/20 cone type moving coil loudspeakers incorporate the latest high efficiency magnet systems. P.H.C. 10 and 20 W.

Greatest Tuning Range and Best Sensitivity of Any Commercial Receiver!

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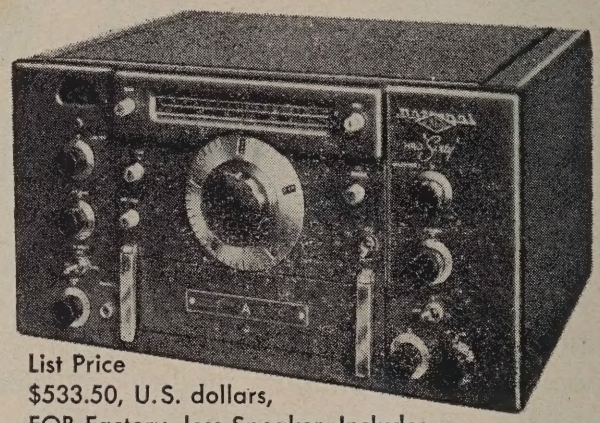
NC®

HRO-Sixty

RANGES: 50-430 kc
480 kc—35 mc
50 mc—54 mc

SENSITIVITY: 1 mv or better at 6 db signal-to-noise ratio.

SELECTIVITY: Utilizes dual conversion and 12 permeability-tuned IF circuits for the highest skirt selectivity ever achieved. Selectivity variable from 8 kc overall to approx. 1200 cps at 40 db.



List Price
$533.50, U.S. dollars,
FOB Factory, less Speaker. Includes 4 coils covering 1.7 to 30 mc with bandspread operation on the amateur 80, 40, 20, and 10-11 meter bands. Additional coils, speaker, rack-mounting for speaker and coil-storage, and other accessories are available at extra cost.

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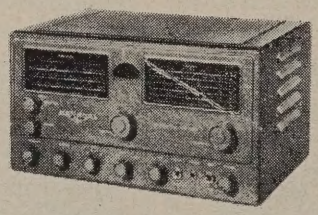
NATIONAL NC-98 is a popular-priced receiver with a range of 550 kc to 40 mc, and many advanced features. U. S. List Price, $149.95



NATIONAL offers models at various price levels, down to $49.95 U. S. List. Every National receiver is outstanding in its class. Complete catalog will be forwarded upon request.

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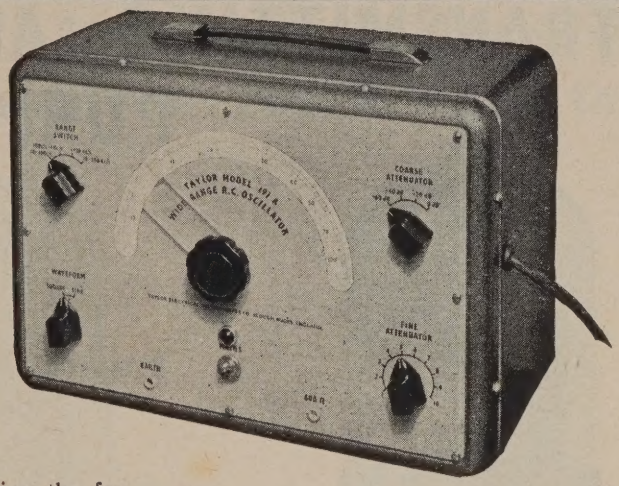
WIDE-RANGE R.C. OSCILLATOR



This instrument generates sine and square waves of exceptionally good waveform over the wide frequency range of 10 c/s. to 100 Kc/s., and provides a convenient source of voltage or low power for checking the frequency and transient response of amplifiers, transformers, loud speakers, etc.

It embodies a conventional Wien bridge type of R.C. Oscillator circuit, thermistor stabilised to give a pure sine wave form of practically constant amplitude at all frequencies within the range of the instrument.

MODEL 191A measures only 12½in. x 8½ in. x 6 in. and weighs 16 lb. 6 oz.

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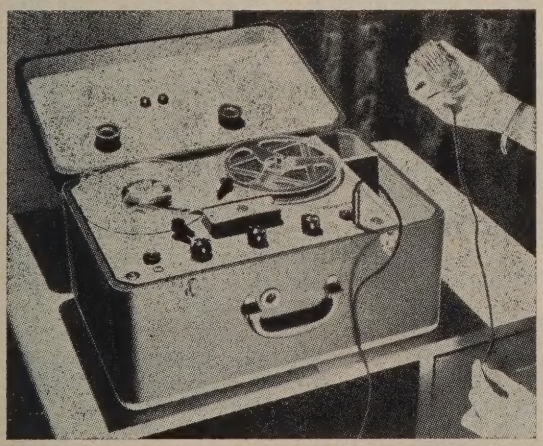
AWA *Magictape* RECORDER



gives
High-fidelity Reproduction with Simplicity of Operation

★ Extremely portable ★ Records anything
★ Two channel recording ★ Instant playback
★ Complete Erase.

No tracks, no needle . . . no scratch, no wear. Supplied in two models, each complete with microphone, spool of tape and empty spool.

Model ST3: 1 hour recording—tape speed 7½ in. per second.

Model ST4: 2 hours' recording—tape speed 3¾ in. per second.

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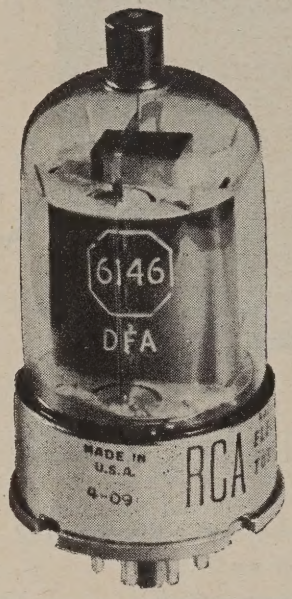

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For information on this and other transmitting types, write to

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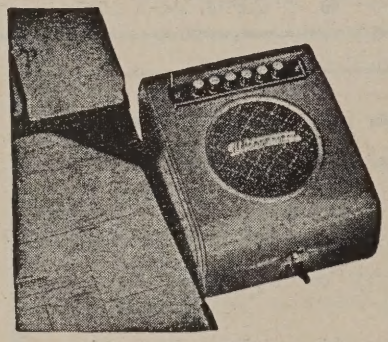
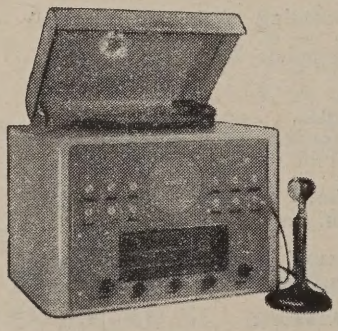
P.O. Box 830, Wellington — P.O. Box 1363, Auckland



Intercommunication



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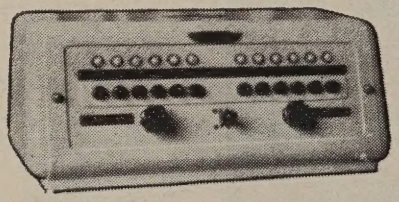
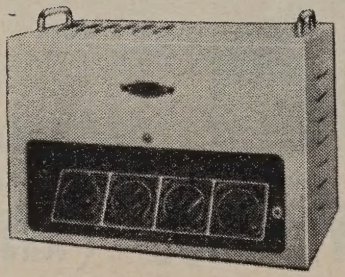
to the Highest Standard



Control Equipment



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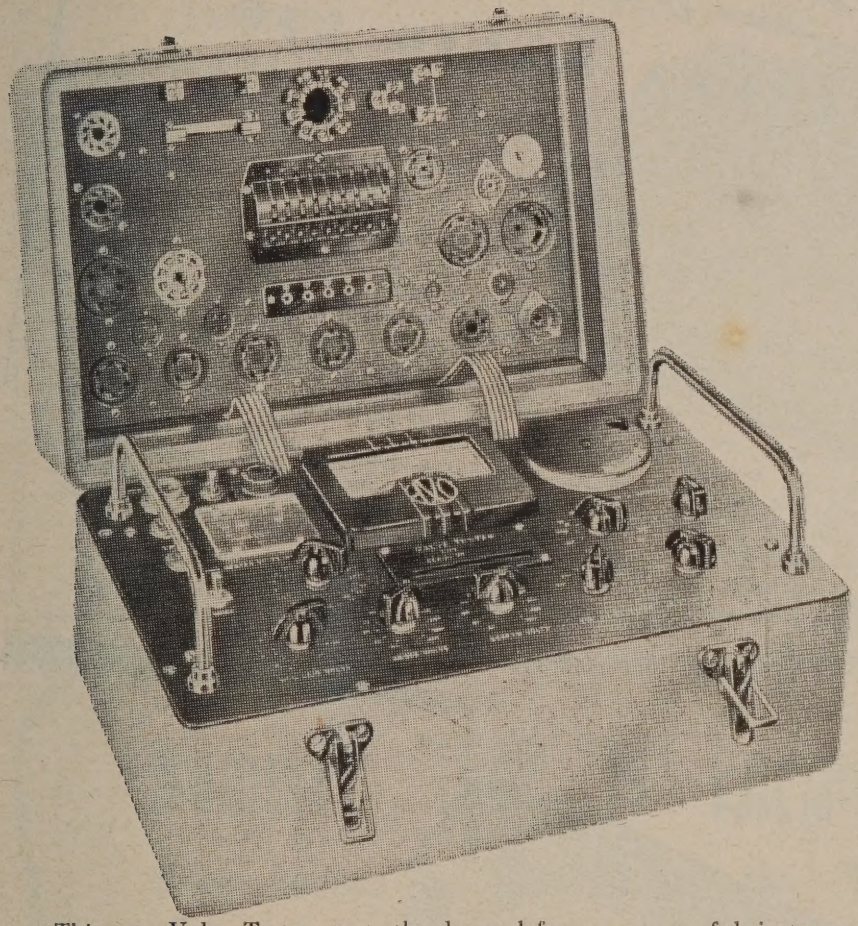
Telephone 30-195

A simple "go/no go" tester which also gives detailed figures of valves' reaction to test



AVO VALVE TESTER TYPE 160

This new Valve Tester meets the demand for a simple-to-use Tester, which will not only indicate the "goodness factor" of a valve but will also, when required, provide more detailed information enabling valve characteristics to be plotted. The instrument employs the well-known "AVO" valve testing system which has been consistently used in various successful instruments since 1937. The new "AVO" Valve tester Type 160 meets all these requirements and, in addition to being compact, light, highly accurate and readily portable, it incorporates a number of novel design features. Full details of the "AVO" Valve Tester Type 160 can be obtained from the sole N.Z. Distributors.

Operates on A.C. supplies from 100–250 volts, 50–500 c/s.

Size:* 15¼ x 10½ x 10 *in.
Approximate weight:* 22 *lb.

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AND ENGINEERING COMPANY LIMITED

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN
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Laboratory Notes

from BEACON RADIO LTD.

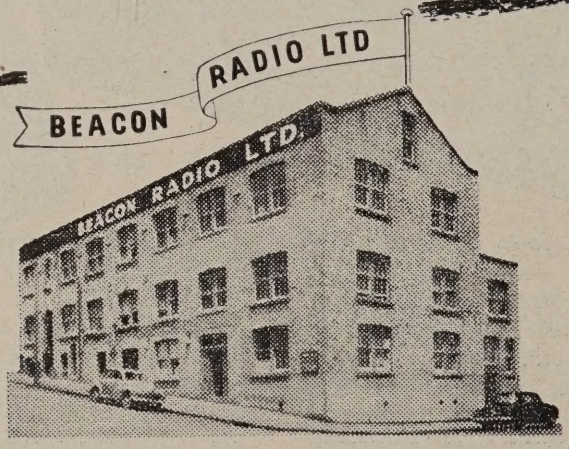
No. 22

INSULATION

If there was a perfect insulator available at a reasonable price it would be universally used. In this imperfect world as with many things some compromise with regard to choice of insulating material has to be arrived at. The engineer finds a bewildering array of detail requiring consideration before any commonly used insulating material can be reckoned satisfactory for the job in hand.

Broadly speaking there are three main headings under which insulating materials can be compared. These are the electrical, mechanical and chemical properties of the insulation. Factors such as temperature, sunlight, atmosphere and contact with other substances, not to mention moisture, insects and fungus can adversely affect all three properties of an insulating material.

The proper choice of material for a particular job and its correct treatment during manufacture greatly extends the normal life expectancy of transformer and other electrical windings.



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SPECIFICATIONS:

Radio: 7 valve R.P.
Consumption: 80 VA with motor running.
Tape Speed: 7½ in. and 3¾ in. per second.
Playing Time: Half hour and 1 hour on 7 in. spools.
Frequency Range: 60-8500 cycles.
Monitoring: Neon or earphones.
Power Output: 4 watts.
Erasure: High frequency.
Public Address System.
Speaker: Rola 6-9L oval.
Control: Hand or foot.
Fast forward: Fast Rewind:
Weight. 24 lb.

THE LONG - AWAITED COMBINATION RADIO AND TAPE RECORDER

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Kit of parts, including valves and speaker but not batteries, 11 Guineas
Batteries, £1/7/2

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YOUR CHRISTMAS PORTABLE!

PORTABLE PERFORMANCE PLUS!

In good localities, during daylight hours, this Portable will receive all main New Zealand stations. At night, dozens of New Zealand and overseas stations can be received.

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IDEAL FOR PICNICS, SEASIDE BACHES, BOATING, etc., etc.

★ DIAMOND LOOP (gives greater efficiency).
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★ HIGH-GAIN MIDGET I.F. TRANSFORMER.
★ FULL CIRCUIT SUPPLIED.
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BASIC KIT includes Chassis, Gang, Coils, Loop, I.F. Transformer, Padder, Scale.

PRICE: Basic Kit, £5 5s. 0d. Cabinet, £3 19s. 2d. extra.

BATTERY DRAIN: Basic Kit can be used with either D91 or D96 series, the latter series resulting in an overall reduction in battery power of 41%.

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Inductance Specialists

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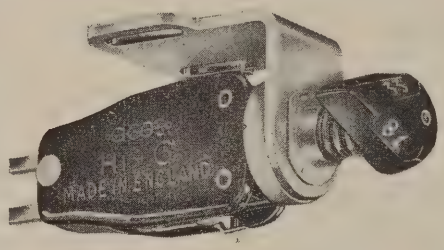
The New Zealand Radio Coil Specialists



HGP37-1 Turnover Crystal Cartridge

Specifications:
HGP37-1 output 1 volt at 1000 cps. crystal capacity 1000 pf.
HGP37-3 output + 4 db. at 1000 cps. crystal capacity 1000 pf.
HGP37-4 ouptut + 10 db. at 1000 cps. crystal capacity 250 pf.
Above specifications are for Standard Records.

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NEW HIGH SENSITIVITY STANDARD

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NEW ATTRACTIVE BOX
IN FULL COLOURS FOR EMITAPE '88'

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7" 1200 ft. . Price 45/-

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In addition to these popular sizes there is an extensive range of Standard and Professional Emitape and Accessories.

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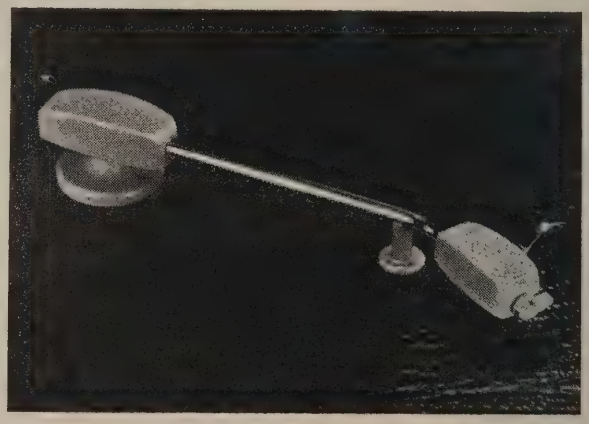
"FONOFLUID"

TURNOVER
CRYSTAL PICKUP



Adjustable stylus pressure
1 to 8 grams
Double ball-bearing swivel
Newly developed pressure regulator
Very high compliance
Lowest intermodulation distortion ever attained

RETAIL £6 6s.
with
TO 284P or TO 284OV
Cartridge

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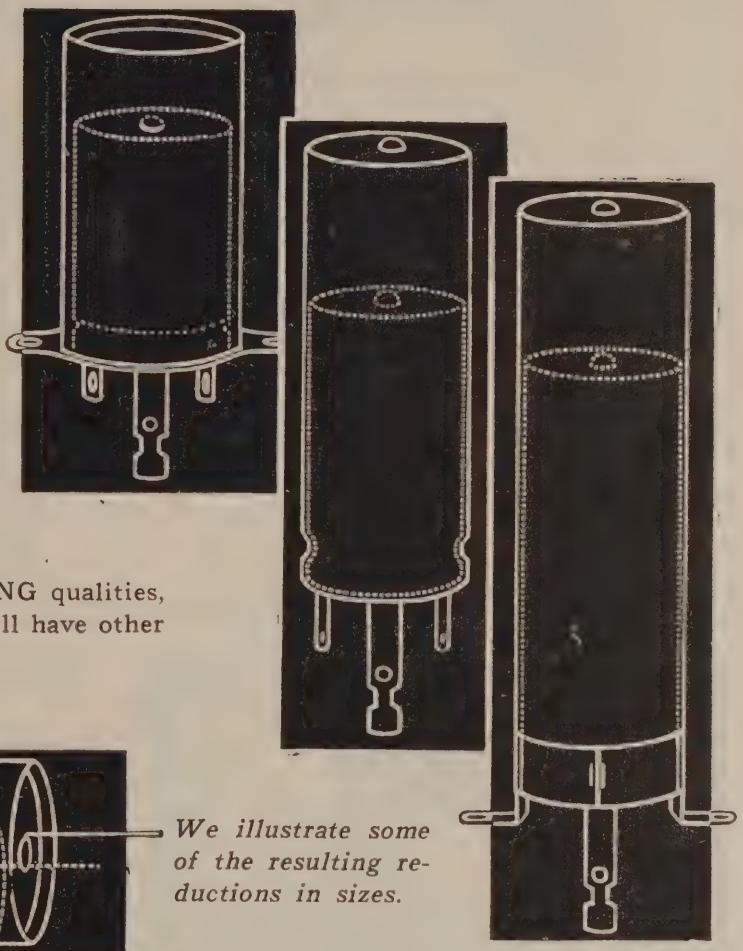
43 Lower Taranaki Street, Wellington Telephone 54-418

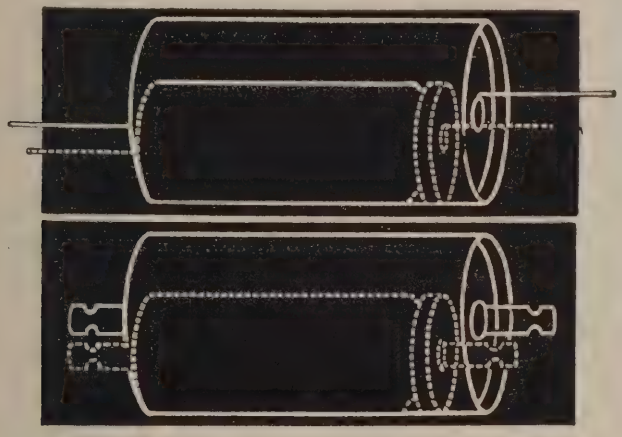
DUCON ELECTROLYTICS

REDUCED SIZES

Using MALLORY techniques, DUCON are reducing the physical sizes of ELECTROLYTIC CAPACITORS. Data Sheets are being prepared for early release.



In addition to the SPACE-SAVING qualities, this new range of Electrolytics will have other improved characteristics.



We illustrate some of the resulting reductions in sizes.

Production has commenced in our new Wright Street Factory, and supplies will be released shortly.

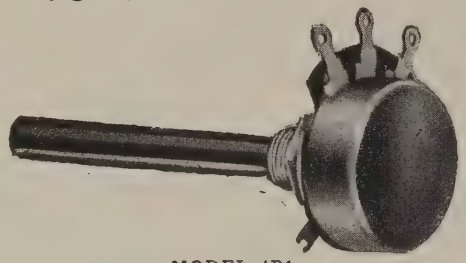
BENEFIT FROM DUCON'S WORLD WIDE ORGANISATION

DUCON (N.Z.) LTD., WELLINGTON

Works: 26 Wright Street, Telephone 52-905. Office: 21 Grey Street, P.O. Box 630, Telephone 42-411.

LESA

VOLUME CONTROLS



MODEL 4B1

FOR EXTRA QUALITY AND DEPENDABILITY

Trade Inquiries Invited by Sole New Zealand Agents:

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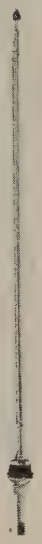
Fred Rothschild and Son

79-83 PRETORIA STREET,
P.O. BOX 170. • LOWER HUTT.

present

ALLGON Antennas BS4-100 in. and BF4.



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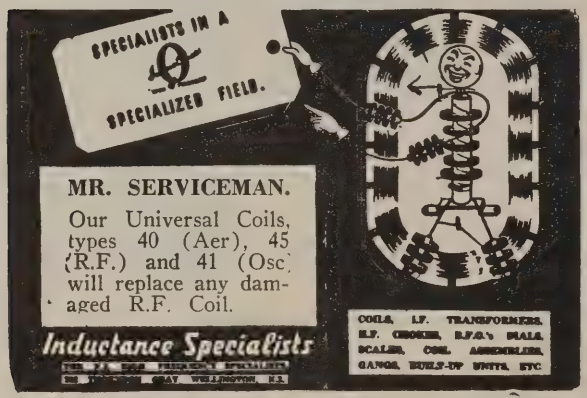
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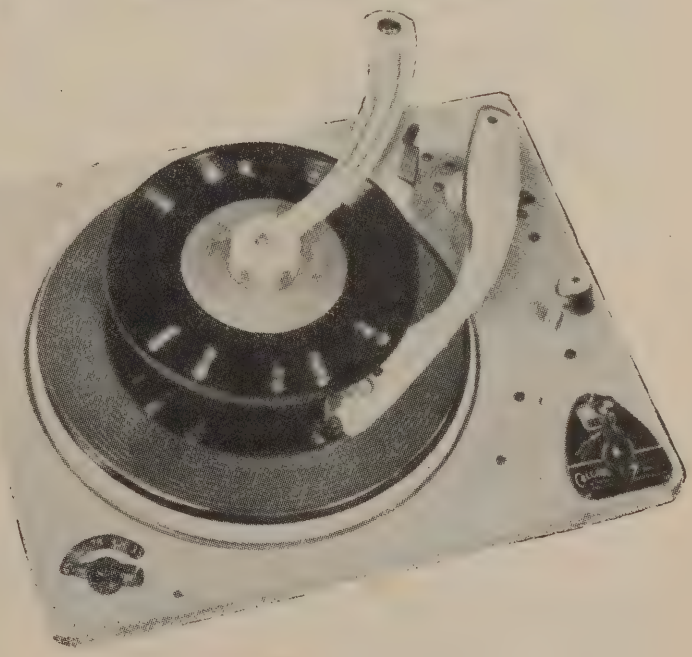

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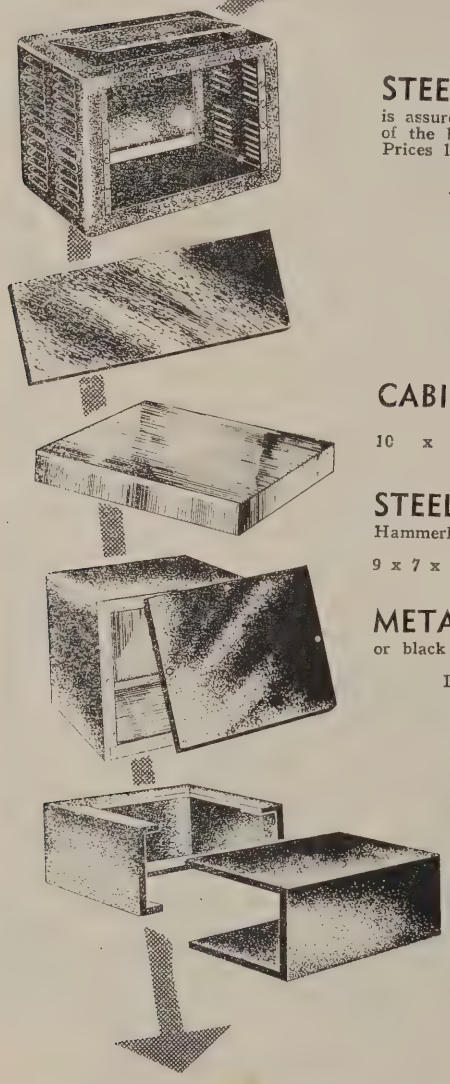

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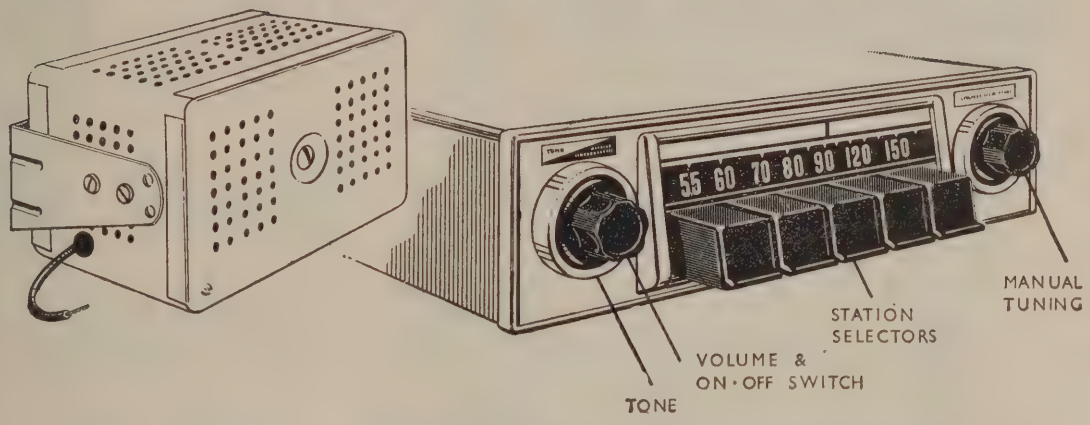

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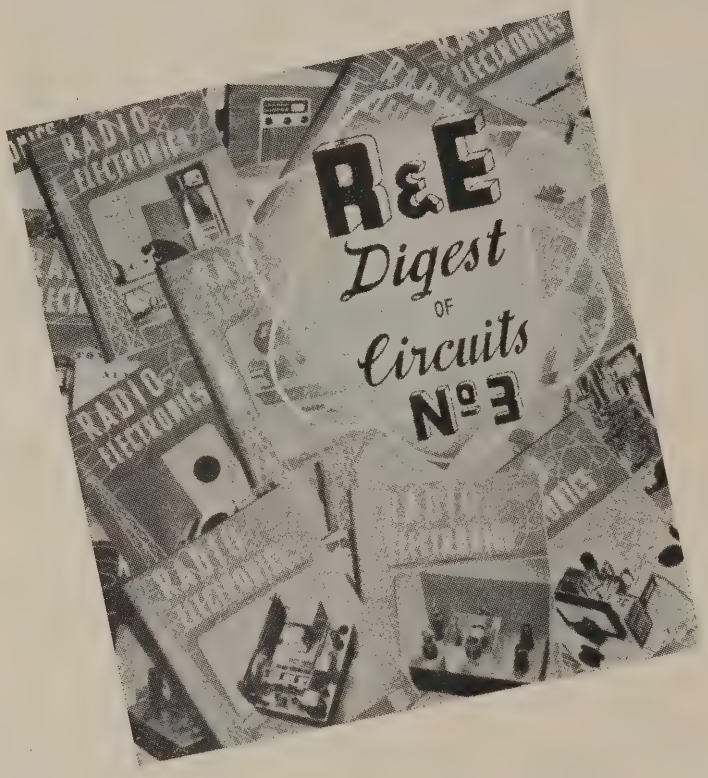

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A Change Of Heart?

On reading overseas periodicals, and in particular those from the U.S.A., it is apparent that the radio and television serviceman is rather better off than is his opposite number in this country. There, in addition to the millions of ordinary radio receivers that require servicing, there are also millions of television sets, which require a good deal more servicing, set for set, than the former. There is also an enormous field of application for the more specialized kinds of radio equipment, such as mobile two-way communication sets, ship-to-shore installations on small private craft, and two-way airfield communication gear in private aircraft. Thus when we say that the serviceman is better off, what we really mean is that he has considerably more scope for his specialized knowledge, which is what enables him to earn his living. It seems to us, however, that the discrepancy is not as great as one might think. True, we have no television here yet, but we do have some of the other things mentioned, and these represent potential sources of income that cannot be ignored. There is one difficulty, however, at least as far as some servicemen are concerned. It is their lack of desire to do anything about them. For example, we heard recently of several servicemen who, after having attended some lectures on television, expressed the opinion that if there was as much in it as there seemed at first sight, the less they saw of it the better they would be pleased. In all fairness, it should be stated that there are probably more servicemen whose keeness is such that they are "rarin' to go" the moment TV looks like putting in an appearance. Unfortunately for them, it looks as if we will all have to wait. In the meantime, could not they turn their attention to other things? For example, while there is as yet only a relatively small quantity of industrial electronic equipment in use in this country, this is a field which is expanding. Yet of how many servicemen does one hear who have taken, or are taking, steps to learn something of industrial electronics, with a view to embracing it as part of their day-to-day work? And how many, since so many thousands of ZC1s were sold after the war, have made anything out of providing service for yacht and launch owners who have put these sets to use? Again, how many servicemen have cashed in on the need for servicing of mobile radio telephone equipments installed in taxis and other commercial vehicles? P. and T. Department figures show that a great many of these are currently in use. They must need servicing, and presumably they are getting it, but how many have had the initiative to cash in on their war-time knowledge of the V.H.F. equipment, and chase after such business?

It is realized, of course, that fields like this are limited in scope, and that if everyone wanted to go in for these specialized branches of the serviceman's art, there would not be enough to go round. But the question of initiative and resource is an important one, and lies at the very root of the independant servicemen's business. It would be interesting to know, for instance, how many registered servicemen work as employees of radio and electrical retailers, and how many run their own independent businesses. Our own guess is that the former class predominates, and as a result, these men are restricted solely to the fixing of domestic receivers. All of which goes to show that there is a place for the independent serviceman who is interested in other branches of electronic work as well.

We have already mentioned the attitude of a certain section of the servicing trade towards TV, and we must admit that we were atonished to hear that this attitude existed at all. This does not look like the New Zealander's allegedly well-known flair for jobs requiring initiative and imagination. Nor does Mr. Clifton-Lewis's remark, reported elsewhere in this issue, that he would not like to see television arrive too suddenly, because he thought the servicing industry would not be ready for it in that time. We were pleased to note that Mr. Clifton-Lewis was taken up on this statement at the conference of the Radio and Television Manufacturers' Federation, where several speakers disagreed with him quite strongly. While on this topic, we would like to put in some opinions of our own. Judging by the tremendous interest that servicemen throughout the country took in TV about a year ago, when it was still hoped that the Government would be favourably disposed towards it, we think that Mr. Clifton-Lewis will be proved wrong, in spite of the fact that some servicemen will undoubtedly fail to take advantage of the new business that TV will offer them. We think, too, that the advent of TV will mean considerable competition in the radio servicing field as a whole. To-day there is no competition, because there is a shortage of skilled servicemen, but in our opinion, TV will change this. True, there will probably be an even greater stortage of skilled men, but dealers will find that they are back to the days when service, and real service at that, had to be given the customer in order to attract him when he is considering buying radio and TV sets. TV sets cannot be tucked under one arm the way a five-valve radio can, and experience in other countries has shown that particularly at first, service departments will have to cope with a large number of calls which turn out to be only for minor adjustments to pre-set controls and even for no real fault at all. This will undoubtedly be a major headache, but for that very reason, the service shop or department which answers such calls willingly, and helps the customer overcome his initial unfamiliarity with his new and complex piece of electronic machinery will reap a rich harvest of goodwill, and therefore of jobs which do pay. Those firms which do not give good service with their television sets will receive less and less custom, and this will be reflected in their sales of radio sets and electrical goods as well.

All this calls for a good deal more progressive attitude than some servicemen appear to have today, and it certainly looks as if a change of heart will have to come in some quarters! Our suggestion is that this might well arrive in advance of television if the more progressive spirits in the servicing business start taking up work other than that pertaining solely to domestic radio sets. The advantages of having perhaps to learn something new will stand them in good stead, as will the need for going out after business rather than waiting for it to come into the shop. The acid test will be when TV does arrive!

AUDIO

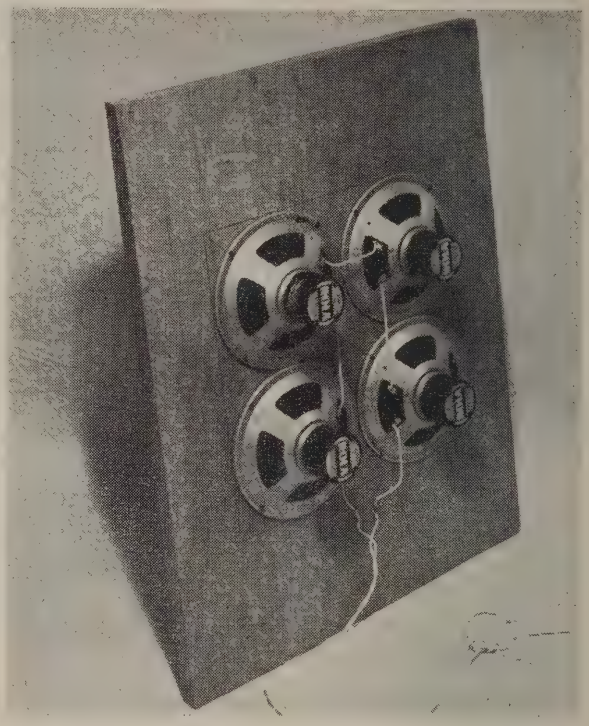
HIGH QUALITY AT LOW COST

(Elsewhere in this issue we have printed an article by the well-known Australian authority, Mr. F. Langford-Smith, describing the results of some experiments in the use of several small, inexpensive speakers to replace one much more costly large one. This short account describes some listening tests of our own, and we are sure that the subject will be of the greatest interest to audio enthusiasts.—Ed.)

INTRODUCTION

It has been known for some time that dividing a given audio power between a number of speakers, instead of feeding it all to a single one, has a beneficial effect on the reproduced quality. We do not refer to the system whereby the frequency range is divided into two parts, and fed to low and high-frequency speakers. This has considerable advantages to be sure, but at present we mean the simple splitting of the audio output by connecting several identical speakers in series or parallel, each speaker having been provided with its own individual baffle, or else the whole lot being baffled by spacing them fairly wide apart on the same flat baffle or open-backed cabinet. Doing this is much simpler than providing a cross-over network and separate bass and treble speakers, and is also less costly. At the same time, the simpler scheme does not possess all the advantages of the more ambitious one. It does, however have a beneficial effect on speaker distortion. There is nothing mysterious about it, the theory being merely that by dividing the power between two or more speakers, the cone movement of each is reduced, and with it the distortion produced by the speakers themselves.

Accordingly, provided the frequency response of the individual speakers is identical with that of the single larger one that would be used instead, nothing is lost, but a rather indeterminate gain is effected, by way of reduction of distortion. In practice, what prevents most people from taking advantage of this effect is that single 12 in. speakers can be had at a quite reasonable price which have a better frequency response than the small speakers that could be used in multiple to replace it. This does not mean that any scheme for using several inexpensive speakers instead of one high-priced one is doomed to failure. In particular, Mr. Langford-Smith's article shows how two or more small speakers might well have advantages, at a much lower price, over the more expensive article.

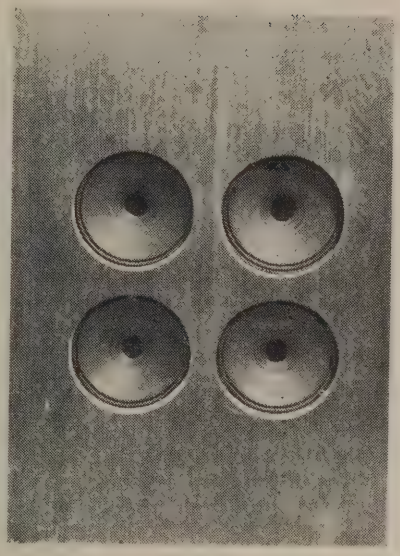


Showing how the four six-inch speakers are mounted as closely as their frames will allow. In our case they were connected in series, giving the combination a total impedance of 14 ohms, so that they could be used with an amplifier matcher for 15 ohms without modification.

PRINCIPLES OF THE NEW SCHEME

It has been found that when several speakers are used, with the audio output divided equally between them, they act quite independently so long as they are spaced quite well apart. That is to say, their response curves and distortion, for a given audio power input, and their acoustical efficiency also, are all identical to the figures obtained for the same speakers used entirely separately under the identical conditions. There is nothing very abstruse in this, as it might have been predicted on the grounds of commonsense alone, but when the speakers are brought closer and closer together, an effect comes into play which could certainly not have been foreseen from any simple thoughts on the subject. As Mr. Langford-Smith shows in his article, there is interaction between the speakers when their cones are very close together, and, moreover, interaction of a beneficial character. In simple terms, the effect is that the presence of the other speakers raises the acoustical efficiency of the remaining one, so that the efficiency of all the speakers is increased.

By acoustical efficiency is meant the ratio between the electrical power fed into the speaker, to the sound power actually produced in the air. For conventional speakers, this figure is very low indeed, averaging only about three per cent. Now one might say that speaker efficiency is a matter of very little moment in these days when large powers, with very little distortion, can easily be generated in high-quality amplifiers. In other words, if a speaker is of good quality, it does not matter very much whether one has to feed four or eight watts to it in order to



The same speaker combination as viewed from the front.

achieve the desired level of sound in the room. This, however, is not the point at issue. Increased efficiency in a speaker, especially if it is produced by some means which does not entail making any structural alterations to it, can only result in less cone movement for a given sound output, and this in turn can only mean that less distortion is produced, at the same time as more sound. On the surface, then, placing two or more speakers very close together appears to be a very helpful device in the search for high-fidelity at low cost. In the article referred to above, Langford-Smith gives the results of measurements made in his laboratory, and relates them to the theory, which predicts that by placing two speakers in close proximity, and feeding them from the same source, the radiation resistance is increased in proportion to the number of speakers so connected. In order to see what this means in practice, let us assume that we have two identical speakers, and that their voice-coils are connected in series. They are fed with a given fixed amount of power; if we imagine that at first, the speakers are spaced apart by several feet, and that apparatus is available for measuring the acoustic power output, we can call this output x watts of sound power. If now we bring the units close together, so that finally, they are mounted on the same baffle as closely as their frames will allow, and measure the power output again, we find that while we have not changed the electrical input power at all, the output of sound power has exactly doubled.

In Langford-Smith's experiments, he worked in a slightly different manner, so as to keep the speakers loaded always with the same amount of electrical input power. That is to say, he took measurements on a single speaker, and then, after adding the second speaker, as close to the first as possible, he doubled the input power so that both speakers were handling the same electrical input as the first one did. Doing this would, if there were no proximity effect, give an increase of 3 db. in the sound power, because 3 db. represents a doubling of power. In practice, however, he found an actual increase of 6 db. in the sound power. The additional 3 db. is obtained, as the theory predicts, from the doubling of the radiation resistance of the speakers when they are placed close together. Likewise, when the same thing was done with four speakers, instead of getting only 6 db. increase in the sound power, which is what can be expected from the increased total electrical input, he obtained 12 db. more output. In this case therefore, the "buckshee" increase in output power amounted to 6 db., or four times the power to be expected from the same four speakers widely spaced so that they act independently.

The distortion measurements were taken under the same conditions, and show that even though each speaker is handling the same power as was fed to the single speaker, the distortion is reduced to as little as 0.4 of the distortion from a single speaker, or from all speakers, had they been widely separated.

In the practical case though, there must be a substantial further decrease in distortion, because when we use a two or four-speaker arrangement, we call upon each to handle only a fraction of what it would have to do were it used alone.

NOT QUITE SO SIMPLE

Unfortunately, in attempting to simplify the explanation as much as possible, we have omitted a very important fact. The increased efficiency due to close spacing does not hold, unfortunately, at all frequencies, but becomes progressively less as the frequency is raised. That is to say, the desirable effect we have been describing does not happen at high frequencies, As can be seen from Fig. 2 in Langford-Smith's article, the theory predicts that the increase in radiation resistance will lessen as the value of a quantity KR decreases. Here, R is the radius of the cones, while K is a factor whose value is proportional to frequency. Thus, in this figure, the full theoretical increase is obtained only at a frequency which makes the value of KR equal to 0.1. The actual frequency at which this happens varies with the size of the cones used, and for six-inch cones is equal to 72 c/sec., so that above this frequency, the efficiency gradually falls off. At 720 c/sec., it is down to 1½ times that of the separated speakers, and at higher frequencies still, it will approach the figure for the separated speakers.

It would appear, then, that using multiple speakers would result in increased low-frequency response, but not necessarily in increased response above the middle frequency range. Theoretically, then, the best application of the principle would be *to use several small, cheap speakers, to replace one large costly one as the low-frequency unit of a woofer-tweeter combination.* On the basis of the theory, one would exepect that if the small speakers had a reasonably level response when used singly, then the close-spacing idea should produce an overall response curve in which the full additional efficiency was realized at the extreme low end, but where only the normal efficiency was experienced at middle and high frequencies. We would thus have an overall response rising at low frequencies, and tending to sound lacking in tops.

In Langford-Smith's article, however, are given response curves, taken under carefully controlled conditions, which seem to show that the 6 db. in-

crease in output for two speakers, and 12 db. for four, is maintained over the whole range of the speakers up to 7,000 c/sec. This apparent discrepancy is not explained in this article, and shows at least that there is plenty of room left for further experimentation.

PRACTICAL RESULTS

So much for the theory of the thing. In order to try out the new system for ourselves, four six-inch speakers of identical make and model, and from the same production run, were obtained and mounted in the manner shown in the photographs. Calculations were made of a suitable reflex baffle for the combination, using the nominal resonant frequency, and the actual working cone area. This was found to be approximately 2½ cubic feet for the particular speakers used, but we did not have a baffle of this capacity available. The nearest was 3½ cubic feet, and this was rendered suitable by using a larger vent than the designed value for the correct-sized box. The vent size was adjusted by experiment until the correct type of response curve was obtained. This was done by feeding the speakers from an audio signal generator, through a series resistor of 25 ohms, and observing the voltage across the voice-coil combination with a V.T. voltmeter. The vent size was adjusted until the required double-humped curve was obtained for voltage across the voice-coils. This curve does not represent the frequency response under working conditions, as the signal generator has an output impedance of some 1,000 ohms, which enables it to act as a constant-current generator for purposes of the test, since the voice-coils in series amount to a nominal impedance of only 15 ohms. As a matter of interest, some of the figures relating to the observed resonant frequencies of the speakers used, mounted separately or together on a flat baffle, and without any baffle at all, are given in the table below.

Speakers	No Baffle	On flat baffle
No. 1	82 c/sec.	79 c/sec.
No. 2	86 c/sec.	80 c/sec.
No. 3	83 c/sec.	76 c/sec.
No. 4	87 c/sec.	83 c/sec.
No. 1 & 3	—	73 c/sec.
No. 2 & 4	—	77 c/sec.
No. 1 & 4	—	74 c/sec.
No. 3 & 4	—	74 c/sec.
No. 1 & 2	—	74 c/sec.
No. 2 & 3	—	75 c/sec.
No. 2, 3 & 4	—	74 c/sec.
No. 1, 3, & 4	—	73 c/sec.
No. 1, 2, & 4	—	73 c/sec.
No. 1, 2, & 3	—	72 c/sec.
ALL	—	71 c/sec.

From this table, several facts emerge:

(1) The individual speakers have lower resonant frequencies when mounted on a flat baffle than without any baffle.

(2) As the number of speakers connected together increases, the resonant frequency of the combination decreases further, reaching the lowest frequency when all four are in use.

(3) Little if any significant difference can be found between the different possible combinations of speakers, in spite of the quite noticeable differences between the individuals.

(4) The resonant frequency of the four when all in use together is some 11½ c/sec., or 13½% lower than the average resonant frequency of the individual units.

From the above, it would appear, at least as a first approximation, that connecting the units in series, as was done in our own experiments, rather than in parallel, as in Langford-Smith's, probably does not produce any untoward effects.

When the four speakers were mounted up, and the baffle adjusted, it was found that the two new peaks were at 52 and 91 c/sec. respectively, with the dip between them exactly on 71 c/sec. With the same measuring set-up, the height of the twin peaks was about half that of the single peak obtained without the baffle.

LISTENING TESTS

As mentioned above, the speakers were connected in series. They had nominal voice-coil impedances of 3.5 ohms, making a total of 14 ohms. This was satisfactory for feeding from an amplifier whose output transformer was designed for a 15 ohm speaker, and accordingly, listening tests were carried out using the prototype "Medium-Powered High-Quality Amplifier" which was described in the June, 1954, issue of this journal, and the synchrodyne tuner described in the September, 1954, issue. The main impression to be gained from the listening tests, which were conducted only with the four-speaker arrangement, was that the upper frequency range was definitely lacking. This seems to bear out the expectation expressed earlier in this article, but while it apparently conflicts with the findings of Mr. Langford-Smith, it should be pointed out that the conditions of the two series of tests differ considerably. Tests on loudspeakers are difficult enough to interpret even when the test conditions are apparently identical, and it should be emphasised that our own work is in no way strictly comparable with that of Langford-Smith.

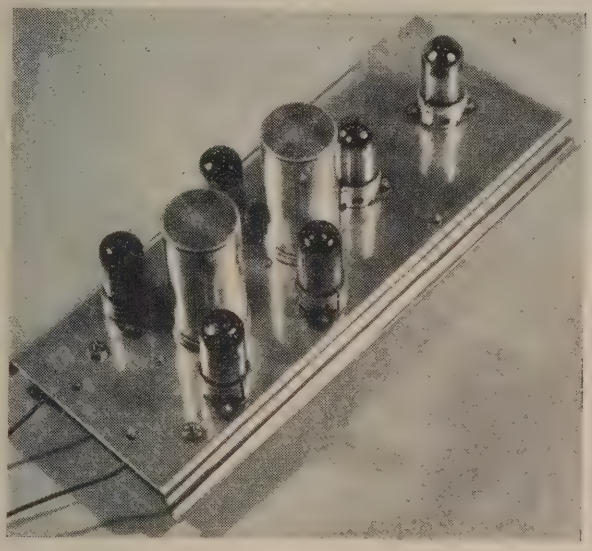
In order better to judge the quality of the combination of four speakers, therefore, we obtained a small horn tweeter, said to have a frequency range from 2000 to 14,000 c/sec., and constructed a cross-over network with a designed cross-over frequency of 3000 c/sec. It was a half-section type, having a roll-off of 12db./ octave below the cross-over. When used in conjunction with the combination, the results were very much improved in realism and brilliance, although the input to the tweeter had to be reduced in order to give a pleasant balance to the reproduction. This was on account of the clearly greater efficiency of the horn tweeter as compared with the low-frequency combination, at frequencies near the cross-over point.

In view of this experience, it appears that the idea of using the four small speakers is basically a practicable proposition, as the audible response was well sustained down to approximately 40 c/sec. Indeed, the reflex baffle seemed to be rather more effective in levelling out the low-frequency response than it is with a single 12in. speaker, which possesses a similar cone area. The middle and low-frequency reproduction was very "clean" sounding, giving an aural indiciation of low distortion, while the tweeter,

(Continued on page 54.)

Circuits for the Experimenter

A Wide-Band Oscilloscope Amplifier



INTRODUCTION.

Perhaps one of the most difficult amplifiers to devise is the one intended for use as the Y-axis amplifier for an oscilloscope. Some of the trouble lies in the almost unlimited choice of specification, and this is especially true when the oscilloscope is to be a general-purpose instrument. It is difficult to decide just what characteristics are the most desirable ones to incorporate, even when the uses to which the amplifier will be put are fairly well settled, but when one is not sure just what work the thing will be called upon to do, the task of specifying the performance of the projected amplifier, before setting out on its design, is quite a formidable one. These days, of course, most of us who are even remotely interested in oscilloscopes and their use conjure up thoughts of television, even if these have so far turned out to be little more than a pipe-dream, and it is with this eventual application in view that many amateur designers decide to make their amplifier flat out to four or five megacycles per second. It is at this stage that the real difficulties start to rear their ugly heads, and before much paper has been spoilt with rough workings-out, it becomes apparent to the startled designer that the device is going to be much larger, more costly and more difficult to build than he had ever thought. Unless this might seem to be quite irrelevant, let us examine just what we are up against when we come to attack such a problem.

SOME OF THE FACTORS INVOLVED

Suppose, for example, that we have decided to make the amplifier flat out to 4½ mc/sec. This is a good round figure, we think, better than the overall response of most TV receivers, so that a really first-class amplifier will result. So far so good. We know that high-Gm television pentodes will have to be used if the required bandwidth is to be obtained with reasonable stage gain, and we know also that these tubes will easily supply the signal voltages required to drive the final stage—the one which is to feed the deflection plates themselves. Where we first strike trouble is in deciding what sort of tube to use for this final stage. It should be mentioned that we have already determined to make the amplifier a balanced one, as we are well aware of the poor picture obtained from the otherwise excellent VCR97 or 5BP1 when one Y-plate is earthed, and a single-ended amplifier is used to drive the other one. Trapezium distortion and deflection de-focussing are to be avoided at all costs, so that we have become resigned to the difficulties inherent in producing a wide-band phase inverter, and to the additional valves that we know will be needed. The first step is to look up the figures for the VCR97, or measure them for ourselves, upon which we find that to fill the screen, a peak-to-peak signal of some 600 volts is required. Next, we look at the characteristics and ratings of a likely wide-band pentode, such as the 6AC7, or EF91, or AK5 (whichever we happen to have a few of on hand) and find that to obtain the requisite bandwidth, we must use a very low value of plate load resistor, of the order of 1500 ohms. As we are to use a pair of the tubes in push-pull, each will have to supply only 300v. peak-to-peak, or 150v. peak undistorted output. This does not look so bad, until we realise that this would entail a peak plate current swing of some 100ma. The smallest D.C. plate current that will make this possible is 50ma., and this is a good deal more than the maximum rated cathode current of all these small valves.

The only way out of the difficulty is to use a valve which can pass 50 ma. of plate current continuously, so that a power pentode to beam tetrode seems to be indicated. This in turn means that the final stage alone will draw over 100 ma. from the power supply, so that by the time the preceding stages have been allowed for, and the time-base circuit, it looks as though a 150ma. power supply will have to be used. When we come to examine this proposition more closely, we find that owing to curvature of the characteristics, a 6V6 or EL33, or similar tube, will not produce as large an undistorted output as we need unless a considerably higher plate voltage than usual is employed, or else a higher value of load resistor. The former solution has obvious disadvantages, while the latter results in a narrower bandwidth. The only other solution is to use still larger valves, such as 807s, which means an even larger power supply.

All this does not mean that nothing smaller than 807s will suffice to swing a 6in. cathode ray tube at bandwidths of 4½ mc/sec. It does indicate, however, the kind of problems that crop up. As a practical example, the writer can quote the case of an actual oscilloscope—a 12in. one—which was required to have a bandwidth of 2mc/sec. The deflection amplifiers ended up after several atempts to use something smaller, with four 807s in push-pull parallel.

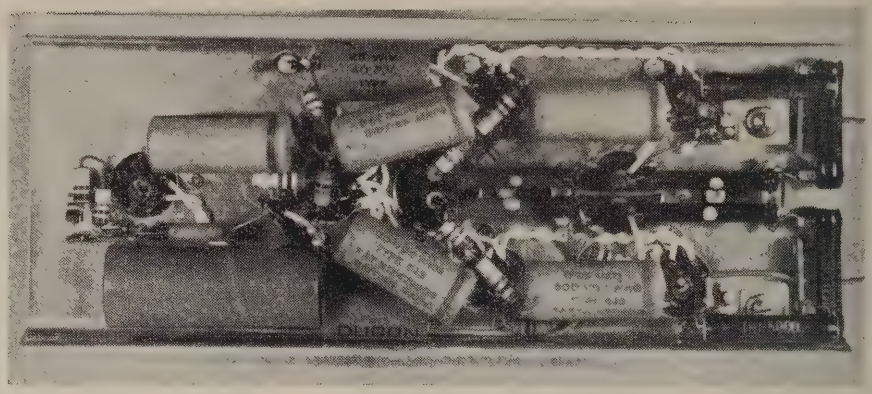
THE CASE FOR LESS BANDWIDTH

This brings up once and for all the question whether or not we can reasonably make do with less bandwidth than the rather ambitious figure we have been discussing. It will probably surprise some

readers to learn that in our opinion, most of the functions that are really needed can be fulfilled by an amplifier whose bandwidth is of the order of 2 mc/sec. There may even be some who will not believe it.

The fact is that in television work, it very rarely happens that it is essential to amplify the whole television signal—sync. pulses, video signal and all—because the best method of viewing the video signal is to see it as its own end product, namely a picture. The 'scope is needed for examining the synchronising waveforms more than anything else, and for this, a bandwidth of 2 mc/sec. is ample, except perhaps in the special case where circuit development is being undertaken, and where precise measurements of pulse rise time, and other similar quantities, must be undertaken. Nor is there an overwhelming need for high amplification. In television circuits, signals are always present at levels of a volt or two except in the early stages of receivers, and the functioning of these is better carried out by ordinary methods than by the oscilloscope. Let us examine the question of gain a little more closely. A signal of 600v. p-p. is needed for a full screen, but such a picture is hardly ever used, because of the curvature of the C.R. tube near the edges. It is good practice to cater for it, however, because this means that for any practical-sized picture, the signal will be virtually undistorted, and easily within the signal-handling capacity of the amplifier. In actual practice, a picture of only an inch or so in height is perfectly satisfactory to work with, so that although we may design the amplifier on the assumption that a full screen is needed, the ability to put up with a much smaller picture when necessary adds several times to the effective gain of the amplifier. Then again, the fact that we are using a push-pull amplifier gives us twice the overall gain of a single-ended amplifier, because the peak-to-peak amplitude of the output signal is the sum of the p-p amplitude of both sides of the amplifier. Thus, if we calculate the gain of one side of the amplifier, the effective total gain is twice the worked out figure. In the case of the circuit which is given in this article, the overall gain is 164 times, from the input terminal to each output plate. This makes an effective gain of 328 times, owing to the push-pull connection, which can now be seen to pay its way handsomely quite apart from the freedom which it gives from trapezium distortion. Had a single-ended amplifier been used, a tube taking a considerably higher plate voltage would have had to be used, or else a pair of smaller ones in parallel, in order to obtain the required signal output voltage, so that using the balanced connection does not necessarily mean that three extra tubes have had to be used.

The figures given above show that for a full screen, a p-p signal of 1.83 volts is needed at the input. Admittedly, this is not very small, but when it is remembered that a signal of one-sixth this value will give a perfectly usable picture, and again that we have been quoting voltages in peak-to-peak values (since the p-p peak amplitude is what we observe on the screen), we see that the amplifier is really quite sensitive enough for all but very special purposes. For instance, it will give a picture 0.46in. high from the output of a gramophone pick-up rated to put out only 50 millivolts R.M.S. from a standard frequency disc.



Underneath view of the amplifier, with the circuit running from left to right. The load resistors for the output stage are made from two 5K.S.W. wire-wound resistors in series. At the right-hand end of the padder condensers can be seen, that are used for final adjustment of the frequency response.

THE CIRCUIT

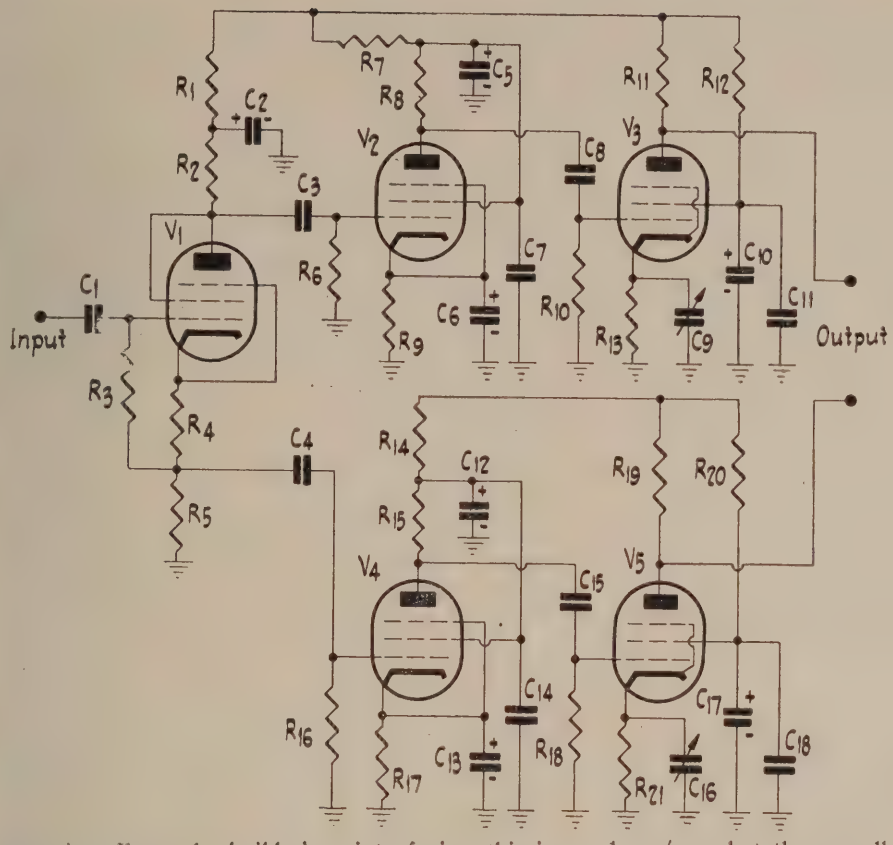
Perhaps the first thing to describe about the actual circuit is its choice of valves. The output tubes are EL42s. While it would have been possible to use other tubes of the same general kind, this type, while a readily available and inexpensive one, can hardly be bettered for the purpose. We did toy with the idea of using one of the special television types for this position, but decided against it mainly on the score of present availability. For the remaining tubes the EF42 was a logical choice, as it also is a rim-lock tube, and is one of the best available for small-signal wide-band amplification.

It will be seen that there are two balanced stages, which are preceded by the phase inverter stage.

The purpose of this arrangement is mainly that of reducing distortion. It will be noted that the plate and cathode load resistors of the phase inverter are very low, and that a large de-coupling resistor is used in the plate circuit of this tube. Both these features limit the voltage-handling capacity of the stage, in the interests of better high-frequency response. It is better therefore, to use the phase inverter in such a position that the smallest possible output signal is required from it. Also, since a balanced 'scope amplifier has the usual facility of cancelling out second harmonic distortion which arises in the individual halves of the circuit, the more of the amplifier that is balanced, the better off we are from the point of view of distortion.

FREQUENCY RESPONSE

One noteworthy feature of the circuit is that the relatively great bandwidth is obtained without the time-honoured use of inductive high-frequency com-



R_1, 33k.
R_2, R_5, 1.5k.
R_3, R_6, R_{10}, R_{16}, R_{18}, 680k.
R_4, R_9, R_{17}, 200 ohms.
R_7, R_{14}, 15k.
R_8, R_{15}, 4k.
R_{11}, R_{19}, 10k. 10w. w-w.
R_{12}, R_{21}, 47k.
R_{13}, R_{20}, 780 ohms.
C_1, C_3, C_4, C_8, C_{15}, 0.25 μf.
C_2, 30 μf. 450v. wkg. Electro.
C_5, C_{12}, dual 40 μf. 450v. Electro.
C_6, C_{13}, 50 μf. 25v. wkg. Electro.
C_7, C_{11}, C_{14}, C_{18}, 0.01 μf.
C_9, C_{16}, 400 μμf. padders
C_{10}, C_{17}, dual 40 μμf. 450v. Electro.
V_1, EF42.
V_2, V_4, EF42.
V_3, V_5, EL42.

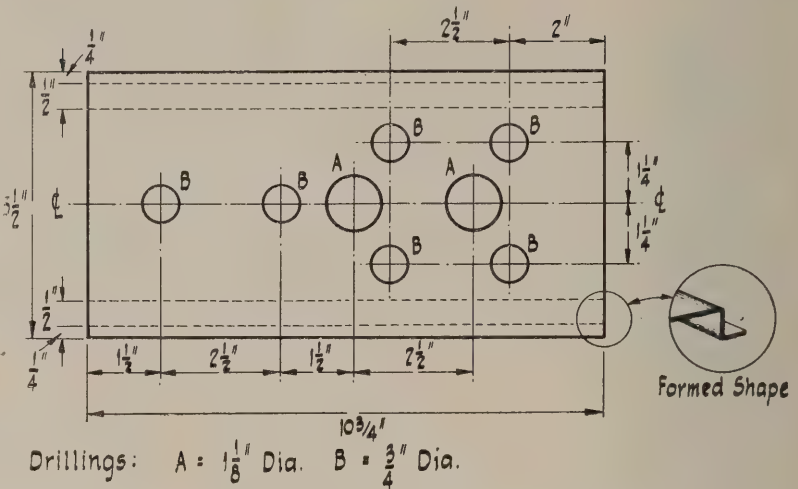
pensation. From the builder's point of view this is a distinct advantage, since there are no compensating chokes to be wound to an accurately known inductance; instead, the high-frequency response of the output stage is kept up by using controlled negative feedback. It will be noted that the cathode resistors of 780 ohms (a non-standard value by the way) are bypassed, not by a high-value electrolytic condenser as might be expected, but by an adjustable padder of only 400 mmfd. maximum capacity. In practice, this will be adjusted to about 300 mmfd. At low frequencies, the gain of the stage is the same as would be obtained without any cathode bypass at all. As the frequency rises, however, the gain rises too, until at high frequencies, the full gain of the circuit is realised, because at these frequencies the bypassing effect of the small condenser is fully effective. This scheme is found in many present-day television receivers for high-frequency compensation of the single video amplifier stage. It has not quite the degree of compensation that the inductive method has, but it has one great advantage. It allows a considerably higher value of plate load resistor to be used than does the inductive method, and so gives a larger output voltage, tube for tube, than does inductive compensation. This accounts for the high plate load resistors of 10k to be found in the final stage of the amplifier.

The EF42 stage has its load resistor chosen so that the upper half-power frequency, where the gain has dropped by 3db., is 2.7 mc/sec. Without compensation, the final stage would be 3db. down at just over 1 mc/sec., but the overall effect of the compensation is to bring the response up so that it is flat up to over 1 mc/sec., and then falls off gradually, being 3db. down at just over 2 mc/sec. This is about the practical bandwidth limit for tubes of the size of the EL42 in the output stage, and it is brought about by the fact that a 10k. load resistor is required if, under the chosen conditions of voltage and current, the tubes are (a) to produce the required output voltage, and (b) to be run within their ratings. It should be pointed out that the EL42s are being run just within their limits, so that no attempt should be made to strain them further. Contrary to what many suppose, modern valves can give excellent service when run at or near maximum plate dissipation and voltage, so that there is little or no point in using a larger tube than is strictly necessary.

POWER SUPPLY

In order to obtain 300v. peak-to-peak signal output from the EL42s, it is necessary to use a supply voltage of 450. This does not mean that the maximum rated plate or screen voltages are exceeded under working conditions, because the actual plate voltage is only 230, the remainder being dropped across the plate load resistor of 10k., by the plate current of 22 ma. The screen voltage, as dropped through the 50k. resistor is approximately 210v., as measured with a 1000 ohm/v. meter on its 1000v. range. As can be seen from these figures, there is a margin between the actual conditions and the maximum tube ratings,

and while it would certainly be possible to increase the supply voltage slightly, there is no necessity to do so, as the full face of the C.R.T. can just be covered by an undistorted signal as things are. The total H.T. drain, which included an input cathode-follower stage, not shown on the circuit diagram, was only 70 ma., which is quite modest considering the bandwidth and signal capability of the amplifier. This leaves a 100 ma. power supply with 30 ma. in hand, to be used for the time-base circuit and its amplifier (which need not be nearly as good as this one) and for a pulse-type E.H.T. generator similar to those used in television receivers. This latter arrangement has already been worked out, and it has been found possible to obtain an E.H.T. voltage of 2.5kv., with automatic voltage regulation, for the expenditure of only 17 ma. at 250 volts. It should thus be possible to build a complete oscilloscope, including the present wide-band Y-amplifier, and the pulsed E.H.T. generator and time-base circuitry, with a single 100 ma. power supply as the only one. As a result, no high-voltage power transformer nor accompanying rectifier and smoothing components will be needed, and the whole 'scope will be most inexpensive in spite of possessing better characteristics than many commercial instruments.



Drillings: A = 1⅛" Dia. B = ¾" Dia.

N.Z.A.R.T. NOTES

(Supplied by the Publicity Committee, N.Z.A.R.T., 25 Lees Road, Christchurch, to whom all inquiries should be addressed.)

A recent practice by the Christchurch Branch Section of the A.R.E.C. in the Eyrewell State Forest area demonstrated the efficiency of portable equipment in heavily wooded areas. With mobile and fixed ZC1's the members of this section showed that both the 80 and 160 metre bands were usable in this type of location.

Surprise of the practice was the performance of a type 208 which had been converted to telephony. This unit was carried into the centre of the area and entirely surrounded by trees. Its signals on the 80 metre band were perfectly readable over a 25 mile path.

Further news from the Christchurch Branch tells us of a proposed beginners' class. Scheduled to commence in the near future, this will cater for instruction in both theory and practical work. Any interested parties in the Christchurch City area should contact the Branch Secretary, or write care of this committee.

Of Dominion wide interest are the Morse Proficiency runs made from station ZKF on 3324 and 6885 kilocycles. These runs are sponsored by the Association and certificates are issued to all applicants who return correct copy. The sponsored runs are made at 9 p.m. on the first Monday of each month and copy should be forwarded to Mr. H. W. Batty, 4 Waratah Street, Birkenhead, Auckland. All copy should be as taken at the time of the run, and, it is possible that intentional errors have been introduced. To qualify, copy must be 100% accurate for a period of at least one minute during the test transmission, which is made at three minute periods at varying speeds. Copy may be submitted for as many speed groups as required. As ZKF transmits a tone modulated signal it can be copied on any standard commercial receiver.

A further service offered by the Association, and available to all amateurs, is the Official Observer Station system. These stations are not acting as policemen. They are there to assist both new chum and old timer alike.

The duty station will be found on approximately 3890 kilocycles and will call on the hour between 7 p.m. and 10 p.m. If you have any difficulties or require any checks it is suggested that you use this service.

Of interest to amateur and listener alike are the Standard Frequency transmissions from ZL2IY. These are made in the 80-metre band on the first and third Thursday of each month. ZL21Y will call as follows: 9.00 p.m., 3899 K/C; 9.05 p.m., 3799 K/C; 9.10 p.m., 3700 K/C; 9.15 p.m., 3599 K/C; 9.20 p.m., 3500 K/C. These quoted frequencies are approximate only and the actual transmitted frequencies will be nominated during the run. At the conclusion of the run ZL2IY will return to 3900 K/C and will listen out for any stations requiring further checks.

With the approach of the new DX season and the consequent improvement (we hope) in the higher frequencies, minds naturally turn to DX contests. At the conclusion of the "Contest Season" we should know if conditions have improved, or whether those advocates of the 22 year cycle really have something.

From the Te Awamutu Branch we learn of the departure of ZL1WS, Lin Rhodes, for Australia. Lin is now operating VK(2)1B from Pymble, New South Wales.

Publications Received

"Cory-Wright and Salmon Ltd. Stock Record," August, 1954.
"The Radio Constructor," Vol. 8, No. 1, August, 1954.
"Electrical Industries Export," Vol. 54, No 8, August, 1954.
"Wireless and Electrical Trader," Vol. 95, Nos. 1240, 1241, 1242.
"G-E Ham News," Vol. 9, No. 4, July-August, 1954.
"Wireless Engineer," Vol. 31, No. 8, August, 1954.
"Wireless World," Vol. 60, No. 8, August, 1954.
"Electrical and Radio Trader," Vol. 1, No. 3, September, 1954.
"Mullard TV Outlook," No. 5, August, 1954.
"The Gramophone," Vol. XXXII, No. 373, June, 1954.
"Radio-Electronics," Vol. XXVI, No. 8, August, 1954.
"Service," Vol. 23, No. 7, July, 1954.
"Technique," Vol. 8 Nos. 1 and 2, January and April, 1954.
"Break-In," Vol. XXVII, No. 9, September, 1954.
"Mullard Technical Communications" (Overseas Edition), Vol. 1, No. 7.
"Q.S.T.," Vol. XXXVIII, Nos. 4 and 7, April and July, 1954.
"Electronic Engineering," Vol. XXVI, No. 318.
"Radio and Television News," Vol. 51, No. 5, May, 1954.

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The Use of Multiple Small Loudspeakers

By F. LANGFORD-SMITH

(Reprinted from "Radiotronics," Vol. 19, No. 8)

At the present time there is considerable interest in the use of multiple loudspeakers, usually from two to four in number, each of which may be relatively inexpensive. Their applications are in two main groups—those in which the speakers are placed close together to obtain increased efficiency, and those in which they are spaced apart to give some form of pseudo-stereophonic effect.

Before proceeding to a consideration of these various applications, let us first consider the basic principles and then examine some test results with closely-spaced loudspeakers.

Basic Principles

The electro-acoustical efficiency of a loudspeaker is a function of its radiation resistance. The actual relationship is given approximately by

$$\text{efficiency} = \frac{R_2}{R_0 + R_2 + R_3} \times 100\% \quad (1)$$

where R_0 = d.c. resistance of voice coil,
R_2 = radiation resistance,
and R_3 = equivalent frictional and eddy current loss resistance.

In order to demonstrate the relationship between radiation resistance and efficiency, the curve plotted in Fig. 1 has been calculated for the case where $R_0 = 16$ ohms and $R_3 = 0$, or for the general case where $R_0 + R_3 = 16$ ohms. It will be seen that, with efficiencies of the order of 1 or 2%, the efficiency is directly proportional to the radiation resistance, to a close approximation.

If any loudspeaker can be acoustically loaded so that its radiation resistance is increased, without its other characteristics being affected, then its efficiency will be increased thereby. One example of this is the use of a horn, which provides additional acoustical loading and hence increases both the radiation resistance and the efficiency, as is well known. Another less known, example is the subject of this article.

If two loudspeakers are mounted as closely together as possible, at low frequencies the radiation resistance of each is doubled. If four loudspeakers are mounted as closely together as possible, then at low frequencies the radiation resistance of each is quadrupled. The complete analysis was made by Wolff and Malter, and put into a more convenient form by Youngmark, as shown in Fig. 2. These curves apply to rigid pistons, but loudspeakers approximate to a rigid piston at low frequencies.

The value of KR is proportional to the frequency and the frequencies corresponding to $KR = 1$ have been calculated for some typical values of piston diameter, expressed in inches for convenience:

Piston dia.	for $KR = 1$ Frequency
3 ins.	1440 c/s
4 ins.	1080 c/s
6 ins.	720 c/s
8 ins.	540 c/s

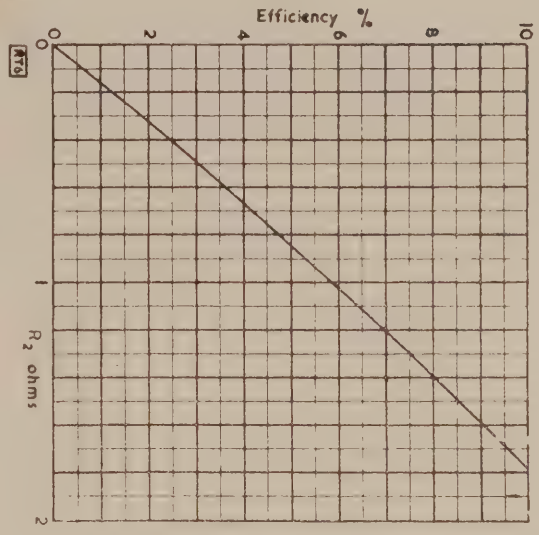

Fig. 1.—Electro-acoustical efficiency of a loudspeaker versus radiation resistance (R_2), for D.C. voice coil resistance $R_0 = 16$ ohms. The equivalent frictional and eddy current loss resistance is assumed to be negligibly small compared with $R_0 + R_2$.

10 ins.	432 c/s
12 ins.	360 c/s
15 ins.	288 c/s

It will be seen from the curves that the value of radiation resistance is rapidly decreasing at $KR = 1$, and it would eventually approach the value for a single piston at higher frequencies.

Thus the application of multiple loudspeakers, closely spaced, is to increase the radiation resistance and hence the efficiency at low frequencies.

The Effect of Increasing the Spacing Between the Loudspeakers

A particular example is illustrated in Fig. 2 for two pistons spaced $6R$ (= 3 diameters). The effect at very low frequencies is much the same as for close spacing, but the fall-off occurs at lower frequencies than for close spacing.

Experimental Results

In order to demonstrate the idea, tests were made on 1, 2 and 4 small speakers (6 inch) mounted as closely together as possible on a flat baffle. Actually 4 speakers were mounted closely together in the form of a square; when less than the full number was in use the others were disconnected and covered over with a piece of timber. As the tests were made in a normal listening-room, the calibrated microphone was mounted 12 inches from the baffle to minimize the effects of reflections. With a single speaker the microphone was mounted on the axis, with two and four speakers it was mounted on the

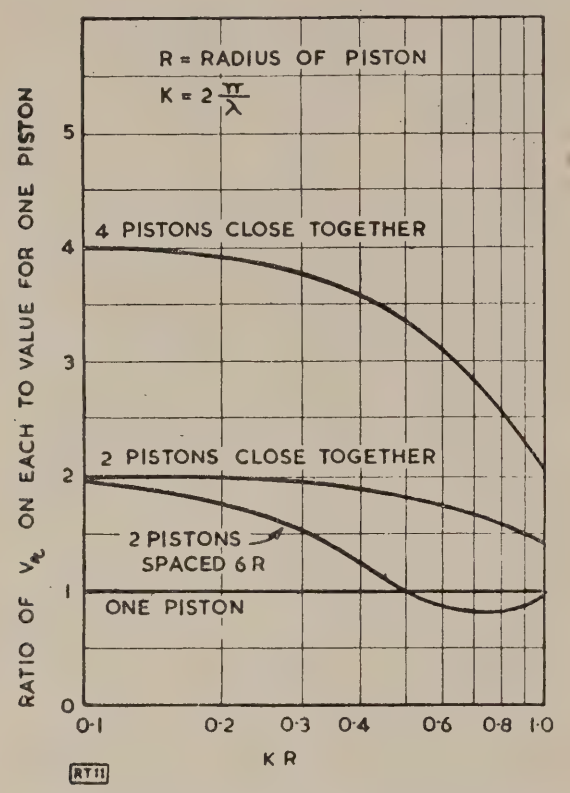

Fig. 2.—Radiation resistance of each of a group of pistons compared with the radiation resistance of a single piston (after Youngmark, based on Wolff and Malter).

axis of symmetry. It is to be expected that the position of the microphone would affect readings at the higher frequencies which are therefore somewhat uncertain, but would not have any significant effect in the low frequency region which was the main object of the tests.

Tests were made during constant peak voltage across the voice coils, using parallel speaker connections in order to eliminate any inter-actions between speakers, as may occur with series connections.

Tests were made on response characteristics, efficiency and distortion.

The frequency response curves are given in Fig. 3. It will be seen that, taking the single speaker as the reference level (0 db), the 2 speaker combination is roughly + 6 db over frequency range from 170 to 1500 c/s. Now the normal increase from the use of two speakers across a constant voltage source, without mutual aiding, is twice the power of 3 db. Hence the aiding effect accounts for the further 3 db rise. In terms of power output, if for example the power output from a single loudspeaker is 0.1 acoustical watt, then the power output from two speakers widely spaced (without mutual aiding) will be 0.2 watt and that from the same two speakers closely spaced will be about 0.4 watt. Thus the effect of mutual aiding is to double the output from two loudspeakers. This can also be considered in terms of efficiency—suppose that the efficiency of a single speaker is 2%, then the efficiency of two such speakers, closely spaced, will be about 4%.

Referring back to Fig. 3 it will be seen that the four speaker combination is roughly + 12 db above the level of the single speaker over the frequency range from 170 to 1500 c/s. The normal increase from the use of four speakers, without mutual aiding, is four times power or 6 db. Hence the aiding effect accounts for the further 6 db rise. The power output will be approximately four times that of the same four speakers widely spaced, without mutual aiding. The efficiency will be about four times the efficiency of a single speaker.

It will be seen that at high frequencies, the experimental results do not agree with the theory. The dicrepancy is not understood, and it was not possible at this time to make any additional tests by moving the microphone around to check directional effects.

A check was made by the direct measurement of efficiency using thermal noise as the source voltage. With two speakers and white noise the increase in efficiency over a single speaker was + 6 db (± 1 db), thus confirming the results obtained from the frequency response curves. With four speakers the readings for increase in efficiency were + 9 db for white noise, + 9.5 db for scarlet noise (0 to 700 c/s), and about 10 db. for blue noise (400 to 16,000 c/s). Although these reading are rather widely spread, and the accuracy of the method used was rather poor, the practical value is not significantly below the theoretical value of + 12 db. for the low frequencies.

Distortion readings were made at selected frequencies from 125 to 400 c/s, measurements being made on a GR wave analyser and calculated as total harmonic distortion (Fig. 4). In interpreting these curves it is important to remember that constant voltage was applied in all cases, and that the acoustical output per loudspeaker for the 2 and 4 speaker curves is approximately twice and four times respectively that for the single speaker. Since the distortion for the multiple speaker is, over this frequency range, at least of the same order or even somewhat better than that for the single speaker, it is obvious that there would be a marked reduction in distortion for operation of the multiple speakers at the same acoustical output per speaker.

Summing up

With closely spaced loudspeakers there are thus both increased efficiency and decreased distortion, so that with two or more relatively inexpensive loudspeakers it is possible to obtain quite good all-round performance. The frequency response curves of Fig. 3, particularly the 4-speaker curve, also show a certain amount of smoothing, especially in the important region from 1000 to 3000 c/s, as a result of the averaging of the response from different loudspeakers.

One important feature for wide-range performance is that the high frequency response of small diameter cones is normally better than that of larger cones, unless these are in the very expensive class of real high-fidelity loudspeakers.

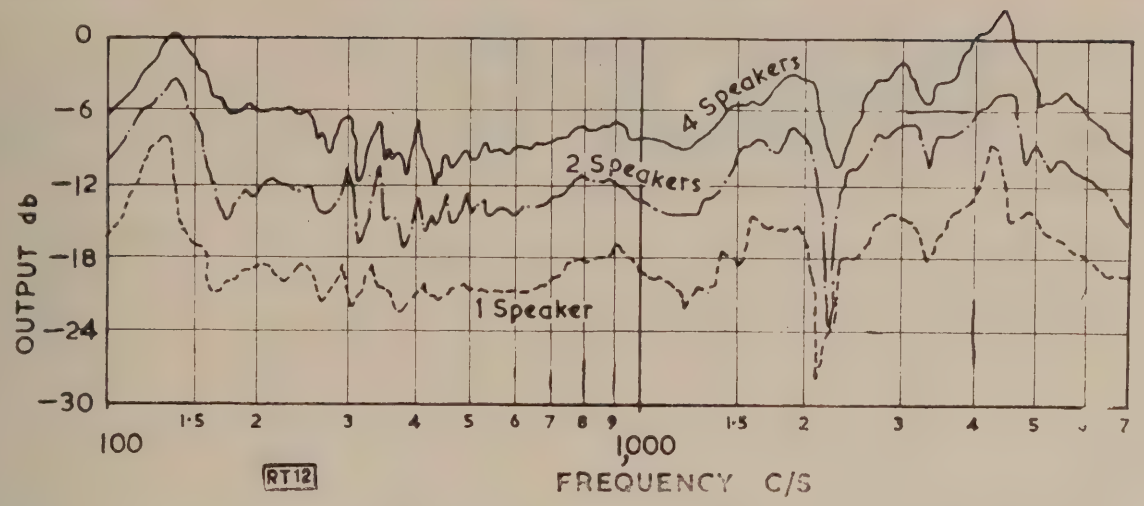

Fig. 3.—Experimental frequency response curves for 1, 2 and 4 speakers, with constant voltage applied across the voice coils, parallel connection, 6½ in. speakers, microphone 12 inches from baffle

A further feature is that the power handling ability of each speaker (the acoustical output power) is increased by the mutual aiding effect without any increased movements of the cone. This is a similar effect to that obtained with horn loading, but to a much smaller extent. It can be looked upon as a pressure wave which loads the neighbouring units.

There is a certain degree of focusing given by loudspeakers in a straight line—this is sometimes used for directional effects in large halls. Because of this effect it is preferable to mount two speakers in a vertical line, and three or four speakers in a small circle to minimize directional effects.

When two loudspeakers are used in a room better high frequency directional characteristics will be obtained when the two axes are a small angle to one another, e.g. 30° to 45°.

One of the minor questions with the use of multiple speakers is the method of connection, whether series or parallel. It is assumed here that the source impedance is very low.

With parallel connection of any number of speakers, the response from any speaker and its damping are both the same as for a single speaker. With series connections of any number of absolutely identical speakers, each speaker will have the same response and damping as that of a single speaker, but in any normal practical case with differences between the speakers it appears that both the response and damping of a speaker will differ from those of a single speaker. It was hoped that there would have been time for tests to be carried out on both series and parallel connections to find which is preferable, but it was not possible to secure four speakers differing sufficiently in their frequencies of bass resonance to make a significant test. It is hoped to describe the results obtained later.

General Applications of Multiple Speakers

Some of the published applications of multiple loudspeakers are given below for the information or our readers.

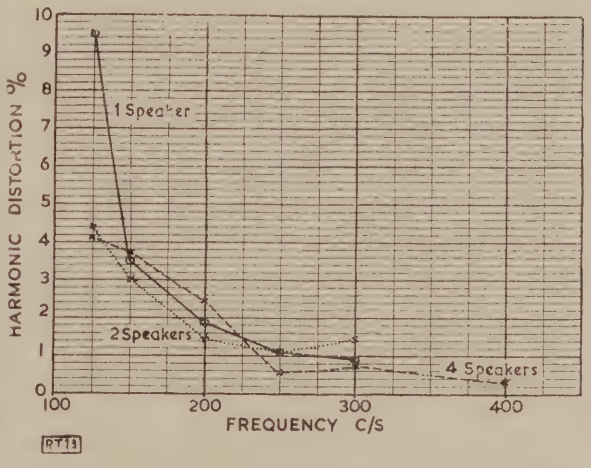

Fig. 4.—Distortion readings for 1, 2 and 4 speakers, with constant voltage applied across the voice coils, parallel connections, 6½ in. speakers, microphone 12 inches from baffle.

The Baruch and Lang Loudspeaker

The Baruch and Lang loudspeaker employs four 5-inch loudspeakers in an enclosure with a volume of only half a cubic foot and is claimed to radiate 0.1 acoustical watt at 3% distortion, with an input of 2 watts and an efficiency about 5%. The response is claimed to be flat ± 3 db from 40 to 12,000 c/s, and the high frequency angular dispersion is 75°. It is a modified acoustical phase inverter (vented baffle) with an array of small holes on one side to provide the requisite port area—15 holes each 15/32 in. diameter spaced 2¼ in. apart.

There is an internal baffle with 21 holes spaced 2 inches apart. These holes provide acoustical resistance to damp down the system resonance to the most desirable degree. In addition, it is claimed

(Continued on page 32).

The PHILIPS Experimenter

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CONSTRUCTION

The set is constructed on a stock chassis measuring 13 in. x 8 in. x 3 in. The photographs in part 2 of this series give a good idea of the constructional methods that were used in the prototype model. At the front right-hand corner of the chassis are the power transformer and the smoothing choke, L_7. Directly behind the transformer is the power rectifier, and behind that again is the output stage. In the front left-hand corner is the pre-selector coil, in front of a diagonal shield, spaced half-way between it and the mixer grid coil, L_1. This shield is 3¾ in. long by 2¾ in. high, and its function is to prevent undesired coupling between the two coils, which would occur owing to their close proximity. The idea is that the only coupling between them should be that due to the link coils, and so the shield prevents direct inductive coupling, giving us virtually complete control over the coupling that is provided purposely. Should too close coupling be employed, the result would be double-humping, and "pulling" between the tuning of the two circuits, and would prevent a definite peak from being obtained. Too little coupling, on the other hand, as could occur if the stray inductive coupling worked in opposition to the link coupling, would result in reduced sensitivity. Directly behind the mixer grid coil is the mixer valve itself. Beside these two components is the main tuning gang condenser, spaced some three inches from the front of the chassis, measured to the front frame of the condenser. This distance was arranged to suit an "Eddystone" full-vision dial, but there is room on the chassis to move the gang slightly either backwards or forwards, so as to make the position suitable for other dials that could be used. For the dial mentioned, there is no need to mount the condenser above the chassis, and it is screwed directly to it. Behind the mixer valve is the first I.F. transformer. Most readers will have recognized the round-can Philips 455 kc/sec. I.F. transformers from the photograph printed last month. These are small, easy to mount, and excellent in electrical characteristics, and therefore admirably suited to the job in-hand. However, should these be unobtainable from your own dealer, the Philips miniature flat-can I.F. transformers will do admirably, or failing these, any transformer of recognized make. The circuit has been spread out far enough for any of the currently available makes to be accommodated in the spaces available without shifting the valve socket holes. This is one of the reasons for the nicely spread out lay-out. The other, of course, is that with the sockets and the transformers much closer together than we have placed them, making a neat and workmanlike job of wiring becomes more difficult, especially for the relative beginner. The circuit progresses from left to right along the back of the chassis with the Philips EAF42, the second I.F. transformer, the detector-cum-first-audio tube, and the output stage, in that order. The only other component above the chassis is the oscillator coil, which is almost directly in front of the second I.F. transformer, and to the right of the gang condenser, nearest the back section of it.

So much for the placement of the main parts. Now if we turn to the underneath view, looked at from the front of the chassis, it will not be difficult to recognize some of the other major bits and pieces. On the right can be seen the two Belling-Lee aerial terminals, and beside them is the two-gang Polar broadcast-type condenser which tunes the pre-selector coil. The ceramic socket close to it is the one belonging to the mixer grid coil,as a close look at the photograph will show. The other ceramic socket into which the pre-selector coil plugs is hidden under the gang condenser. It is not directly underneath, being slightly to the right, but it does not come out in the photograph. Also hidden is the short piece of twisted hook-up wire which runs between the two sockets, connecting the link coils together. The oscillator coil socket can be seen almost plumb in the middle of the chassis, and is about three inches from the ECH42 socket. This makes one of the leads from the tuned circuit to the valve socket about three inches long, while the other is very short, as it is taken from the opposite side of the gang condenser, which lies between the coil and the valve. The 50 $\mu\mu$f. blocking condensers both have insulated terminal lugs provided so that the ends which connect to the tuned circuit may be firmly mounted, and these can be seen to the left of the mixer socket, which is partially obscured by these two condensers.

Both the I.F. transformers are mounted in such a direction that their terminal lugs, which are in groups of three, are centred on a line running parallel with the sides of the chassis. Before mentioning the wiring of these important components, we should point out what may not be generally known about these particular transformers, namely that the windings are all tapped, and that the tapping point is not the centre of the winding. How the circuit diagram has been drawn showing I.F. transformers without tapped windings. This was done on purpose so that those who wished to use other, untapped transformers would not gain the impression that only the tapped variety would do. In the prototype, however, we did make use of the taps, for the following reason. In a communications receiver, selectivity

is the main consideration, provided always that sufficient gain is available. Very often we talk blithely about the "Q" of I.F. transformer windings, without bothering very much what happens to it when the transformer is actually connected into a circuit. In practice, the "Q," upon which the selectivity of the set directly depends, is materially reduced by the plate resistance of the valve, which is shunted across the primary winding. One way of improving matters is to use valves with higher plate resistances, but this is hardly practicable, since modern valves are hardly susceptible of improvement in that respect. The other is to connect the plate of the valve to a tap on the winding instead of to the "hot" end. Doing this places the plate resistance of the tube across only a portion of the winding, and so reduces the shunting effect, thereby allowing the "Q" of the circuit, under actual working conditions, to approximate more closely to the unloaded "Q," as measured on a Q-meter. In turn, this improves the selectivity of the circuit. When this scheme is carried out on both transformers, and, moreover on both sides of it, the selectivity of the whole set is substantially improved.

With these transformers, the tapping point is approximately two-thirds the way up each winding, and so it is important to know which end to use as the "earthy" end. To identify this, hold the transformer with the line joining the centre lugs of the two groups in the "north and south" direction. Then,the earthy ends of the windings are connected to the upper right-hand lug and the lower left-hand one. The tappings are brought out to the centre lugs, while the "hot" ends are the remaining two. Thus, the plate of the mixer, and the grid of the I.F. stage are connected to the centre lugs; the plate bypass condenser and decoupling resistor are soldered to the lower left-hand lug, while the A.V.C. bypass condenser is connected to the right-hand lug. All this refers to the photograph as viewed from the front, underneath, and a close look at the first I.F. transformer in the upper right-hand corner of the picture will enable the connections to be seen. The "hot" ends of both windings are left unconnected. At the second I.F. transformer, the plate is connected to the tap on the primary, but the 50 $\mu\mu$f. condenser feeding the A.V.C. diode is connected to the "hot" end of the winding, thus effecting a compromise, with the idea of obtaining the greatest possible A.V.C. voltage, while not shunting both the diode and the plate of the I.F. valve right across the winding. On the secondary side, the detector grid condenser and grid leak are taken to the tap, and the "hot" end is left unconnected. Should all this be a little difficult to follow, it is a simple matter to take the easier way out, and ignore the taps altogether, wiring the set exactly as in the circuit diagram, but the result will be a set with not quite as much selectivity.

SOME LONG LEADS

We have all, at one time or another heard of the virtue of short leads in a radio receiver, and, by implication, the vice of allowing there to be long leads! But like most sweeping statements, this one needs to be qualified. Strictly speaking, the leads which really should be kept short where possible are those carrying R.F. voltages. In this connection, the term R.F. should be taken to include oscillator and I.F. voltages, and under appropriate circumstances, it can even be legitimately extended to include leads carrying audio! In general, therefore, we lay out circuits so that as far as possible, long leads in the R.F. section automatically do not occur. Readers will remember that a few paragraphs back we had the occasion to remark on the length of an oscillator lead of three inches! This is because in most cases it is not too difficult to lay out the main parts so that no lead carrying R.F. need be longer than an inch or so It is equally true, however, that many leads in a set can be as long as we like. These are the ones which do *not* carry R.F. voltages, as defined above, and they include those carrying only direct current or voltage. Obvious leads which qualify are those carrying the H.T. voltage round the set, but not-so-obvious ones are those carrying A.V.C. voltage, or bias voltages of other sorts. Now it is easy enough to make a statement like this, nor is it difficult to understand why, but the practical problem of ensuring that these leads DO carry only D.C. is not always so easy, especially to those unversed in the mysteries of lay-out. It is felt that some of the wiring rules, as exemplified in this set, will help readers not only to duplicate this set, but also in wiring up their own lay-outs as well.

In the circuit diagrams, it is not always possible to place the components just as they will be put when the circuit is constructed, but as far as possible this is done. For instance, it is usual to draw the A.V.C. bypass condensers close to the coils whose ends they bypass, and similarly, to draw the plate bypass condensers and plate decoupling resistors close to the H.T. ends of the plate windings of R.F. and I.F. transformers. Often, though, beginners do not realise that this is how the actual components ought to be arranged, too. For instance, if one does not realise that the leads from the bypass condensers should be as short as possible, it is very easy to put the condenser several inches away from the point it is supposed to bypass, and the decoupling resistor several inches further on. In many cases, the effect of wiring in this way is just as bad as leaving out the components altogether, and sometimes it is worse. But *if both the condenser and the resistor* are connected to say, the earthy end of the plate winding as close as is physically possible, then the H.T. lead running away from the resistor can truly be regarded as carrying D.C. only, and can be run anywhere through the set without causing instability. Exactly the same considerations apply to A.V.C. circuits, which are even more important if stable operation of a high-gain circuit is to be obtained. And since an A.V.C. lead, which runs round three or more stages cannot possibly be kept short, it is essential that good wiring practice be followed. In the photograph, the plate and A.V.C. bypass condensers associated with the first I.F. transformer can be seen quite clearly, wired right up to the transformer lugs. The A.V.C. lead is the black one running away towards the back of the chassis, where it joins two others, and travels right round the chassis, in the corner all the way, until it gets to the manual gain control, to which the Manual/A.V.C. switch is attached. The A.V.C. line goes to the common terminal of the switch as the circuit diagram shows, and the other two leads are those from the bottom of the A.V.C. load resistor, and the bottom of the A.V.C. decoupling resistor respectively. These are the very small 1 Meg. resistors which can be seen wired to a terminal strip right at the back of the chassis, very close to the I.F. valve socket. Note

how these two resistors are wired to the A.V.C. diode pin on the valve socket with no more than ¼ in of lead, after which the leads run round to the switch with the A.V.C. line. Now, had we placed these resistors at the switch, at least 18 in. away, leadwise, these long leads would both be at a high I.F. potential—up to 40 or 50 volts on strong signals—and no one could complain if the set oscillated. As it is, it is perfectly stable, so that we have complete freedom to place the gain control with its switch where it is most convenient, without worrying about short leads in the least. Note also, that the back bias resistors are both wired in right at the switch. This time, it is because the switch lugs form convenient tie-points and save us from having to mount separate lugs for these resistors. Other long leads are those to the audio volume control, but these have been enclosed in shield braid, because they carry audio voltage, and would most likely pick up I.F. were this not done.

ALIGNMENT

The alignment of a simple set like this one should hold no terrors even for the newcomer to superhet construction. The main job is to align the I.F. transformers carefully. Luckily, the exact frequency is not important in a set of this kind, so that the job can be done even without a signal generator. First of all, set the secondary slug of T_2 mid-way along its travel, then, with a signal tuned in, or with noise picked up in the absence of a signal, roughly peak up the primary of T_2 and the secondary and primary of T_1, in that order. While this is being done, the 10k, regeneration control should be set with minimum resistance in circuit, killing the regeneration. The next step is to advance the reaction control until the gentle hiss indicating detector oscillation is heard. Back off until the oscillation is just stopped, and WITHOUT TOUCHING THE SECONDARY of T_2, carefully peak up the other three slugs in the some order as before. The I.F. stage can then be considered lined up.

The coils should be carefully made according to the directions given, and it will then be found that alignment is almost perfect. In order to obtain the best possible results, tune in a signal at the high-frequency end of the band, and adjust the oscillator trimmer for maximum response. This will involve shifting the trimmer and re-tuning with the main dial, then observing whether the signal has increased or decreased. When the best setting has been found, the alignment at the low-frequency end can be touched up by spreading or squeezing the turns of the oscillator coil very slightly. The whole process is strictly analagous to that of aligning a broadcast receiver, with the oscillator inductance trimming taking the place of the padder condenser.

PERFORMANCE

No one need fear that the performance of this little set will not be good enough. Tests on the air, using very indifferent aerials have shown that it will pull in almost anything on the 80m. band that anyone is working, including quite weak Australian amateurs on the 80m. 'phone. In our opinion, the set will be found good enough to use for a considerable time, until the beginning amateur feels he needs superior performance, after which it might well be placed in cold storage to act as a stand-by receiver.

Use of Multiple Small Loudspeakers

(Continued from page 29.)

that, because the holes are distributed over a large area, the radiation impedance of the array is equivalent to that of a 21 inch cone.

The speakers employed are standard low-cost replacement units, modified to meet the requirements of the system. The optimum dimensions of cabinet and holes, as well as the configuration of holes and the speaker array, are determined by the characteristics of the particular speakers used.

This is a most interesting high-fidelity loudspeaker and enclosure which has been designed to bring the cost within reach of those with limited means—a commercial model is now selling in U.S.A. for less than 25 dollars. The acoustical power output for low distortion is only about a quarter of the value generally regarded as a desirable minimum for large and expensive high fidelity systems.

Two or three 6 inch metal cone loudspeakers are used, closely spaced, in a vented baffle with suitable internal acoustical damping, in the G.E.C. enclosure.

A further application of closely spaced loudspeakers is a corner arrangement of 4 loudspeakers, each with an entirely separate enclosure filling an angle of 22.5°. Acoustical internal damping is used.

Multiple loudspeakers are also used, spaced apart, to provide some form of pseudo-stereophonic effect. One example is the Columbia 360 phonograph which has two loudspeakers spaced apart and pointing in opposite directions.

Another example of the use of multiple loudspeakers spaced apart is the Columbia XD sound system in which a pseudo-stereophonic effect is provided by using a small loudspeaker for the high frequencies, radiating at a point removed from the main loudspeaker in which the frequency range is restricted to the low frequencies.

A still further example is the Kelton loudspeaker, developed by Henry Lang. This uses two speakers in an enclosure 11 x 11 x 23 inches, each in a separate compartment. The 6 inch speaker faces outwards near the top, while the 8 inch speaker faces downwards into a padded cavity with holes for the bass outlet. The back areas of both speakers are filled with sound absorbing material—back radiation is not used. The design is critical. It is designed for maximum performance for a limited outlay of less than 50 dollars in U.S.A.

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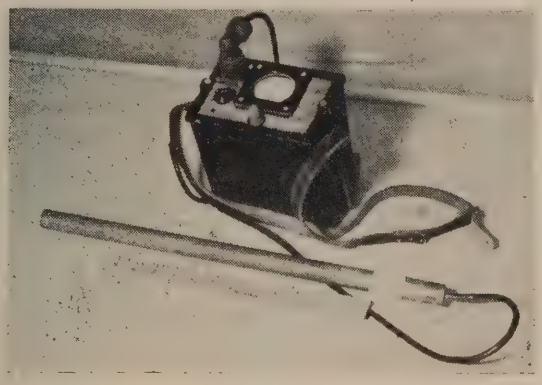
THE GEIGER-MUELLER COUNTER

By J. F. McCAHON

Editor's Note.—Since uranium-hunting has now become of much practical interest in many countries, not excluding New Zealand, we think it might be timely to reproduce the accompanying article, which we published originally in the January, 1947 issue of "Radio and Electronics." A later article will describe practical arrangements for a home-built counter suitable for prospecting work.

At the time of the atom bomb test at Bikini Atoll, a great deal was heard in newspaper reports of the Geiger-Mueller counter, but to many people its action and uses still remain a mystery. The purpose of this article is to explain the principles of this extremely useful instrument.



A portable counting-meter, together with its Geiger-Mueller tube, which is enclosed in the brass tube in the foreground.

The G.M. counter is by no means a new development. The principle was first used by Rutherford and Geiger in 1908, to count alpha particles from radium, but before going further, we must say a little about Radioactivity.

The atoms of a radioactive element are unstable, and disintegrate, giving off powerful radiations in the process. Those from natural radioactive atoms are of three types: Alpha particles (written, α) consisting of the neuclii of helium atoms, ejected with very high velocity from the neucleus of the disintegrating atom; Beta particles (β) which are electrons of high energy; and Gamma (γ). These latter are electromagnetic waves, similar to light or X-rays, but of much shorter wavelength than even the latter. All these radiations have the property of ionizing gases. That is, they can tear from the outer electron structure of a gas molecule one or more electrons, leaving the molecule positively charged. This molecule is then called a Positive Ion. The electron, or a molecule to which it may attach itself is a Negative Ion. Thus we get equal numbers of +ve. and —ve. ions which, left to themselves, would eventually neutralise each other, to reform neutral molecules.

An α particle has a powerful ionizing effect producing about 100,000 ions for every centimeter of its path in air, but even the most energetic of them can penetrate only about eight centimetres of air, and are stopped by a very small thickness of solid matter. β particles have a much smaller ionizing power, and correspondingly greater range. It takes about 100 times the thickness of solid matter to stop them than that required for α's. They can penetrate thin sheets of metal quite easily. γ rays have very little ionizing power, but high penetrating power. It takes several centimetres of lead to reduce their intensity appreciably.

This property of ionization is the basis of most methods of detection and measurement of these radiations. The simplest arrangement is that known as an ionization chamber. It consists essentially of two electrodes separated by an air space in which the ionization takes place (Fig. 1). If now a potential is applied, the ions will be drawn across to the electrodes and produce a small electric current. The effect is so small that the ionization due to a great many α particles is needed to produce a measureable current. About 50 volts is sufficient to cause nearly all the ions to reach the electrodes.

If now the voltage is increased to several hundreds or even over a thousand, and the pressure of the air reduced, the ions will travel towards the electrodes with sufficient velocity to ionize other molecules in their path. These then travel towards the electrodes themselves and the process is repeated. Thus the original ionization is amplified enormously, and it is possible to obtain a measurable current from one particle, and so to count individual particles. Rutherford and Geiger used this principle in 1908 to count α particles. Their apparatus consisted of a cylindrical —ve. electrode, or cathode, in the centre of which was the anode, or positive electrode, in the form of a fine wire. The tube contained gas at low pressure, and the α's were admitted through a thin

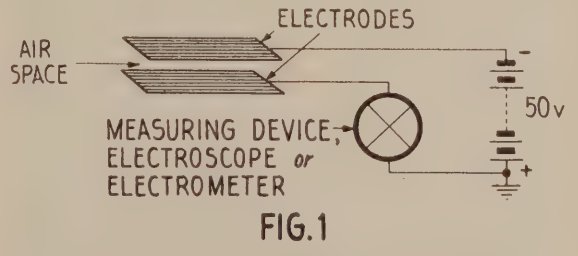


FIG.1

Showing the arrangement of a simple ionization chamber, the forerunner of modern counting tubes

mica window. There were no valve amplifiers available at that time, so an electrometer was used to detect the pulses of current, which had to be counted individually by an observer. This was just as laborious a method as that of counting the scintillations

of light which the particles cause on a screen of zinc sulphide, and as the latter method was simpler to set up, it was generally used.

By the 1920's the development of vacuum tubes had made it possible to devise circuits which would record the pulses automatically, and the counter came into general use. From that time on a large amount of research has been done on the construction and use of counters. In 1928 Geiger and Mueller pointed out the advantages of cylindrical counters over other types. This type of counter is now generally known as a Geiger-Mueller counter. About 1930 the development of coincidence counting circuits increased the usefulness of G.M. counters still further, especially in the field of cosmic ray research. It was not until about 1939 that an accurate picture of the mechanism of counter action was obtained.

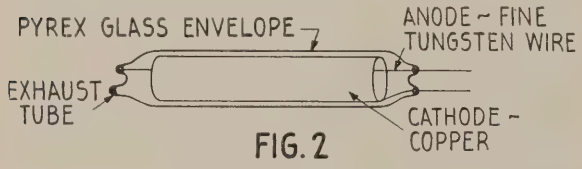


FIG. 2

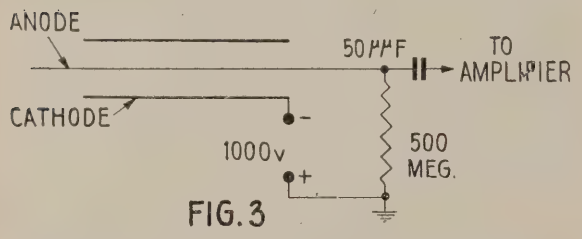


FIG. 3

These figures show, structurally and electrically, the make-up of a Geiger-Mueller counting tube.

A common design of G.M. counter is shown in Figs. 2 and 3. It consists of a cylindrical metal cathode, through the centre of which a fine wire is stretched as anode. The whole system is sealed in a glass envelope containing gas at low pressure. A potential of about 1,000 volts is applied between the electrodes, with the cylinder —ve. It can be shown that the electric field between the two electrodes is most intense close to the wire, the effect being greater the finer the wire is made.

Suppose now that a molecule of the gas between the electrodes becomes ionized. The negative ion is initially a free electron which is immediately drawn towards the anode. Collisions with gas molecules prevent its gaining any great velocity until it reaches the region of intense field near the centre of the tube. Here the electron gains enough energy between collisions to ionize the molecules with which it collides. The electrons thus produced, cause more ionization as previously described. Thus a single electron has produced an avalanche of others which travel with it towards the central wire. During this process, a small amount of light is produced, some of which is of short enough wavelength to eject electrons from the cathode surface; a process similar to that in a photo-electric cell. These are then drawn to the anode and the discharge spreads through the whole length of the tube. It may seem that we have now reached a state of steady discharge, but another effect now comes into play which prevents this.

We have up till now, neglected the +ve ions produced in the discharge. They are thousands of times larger than the electrons and so far have hardly moved from the position they were in when formed. They form a sheath round the anode, and being themselves positively charged, reduce the field intensity close to it, and prevent the formation of further ions. All the electrons are then drawn to the anode and the discharge stops. The time taken to complete this process is of the order of one ten-millionth of a second, but in that time as many as a thousand million electrons may have reached the wire. The +ve. ions now move out to the cathode relatively slowly, and on striking it, may liberate secondary electrons. These then move towards the anode, and we would expect the discharge to start all over again.

This can be prevented in several ways. The simplest is to use a very high resistance in series with the anode, as shown in Fig. 3. The anode then has a considerable —ve. charge for some time after a discharge has occurred, and the voltage across the tube is not high enough to cause a second one.

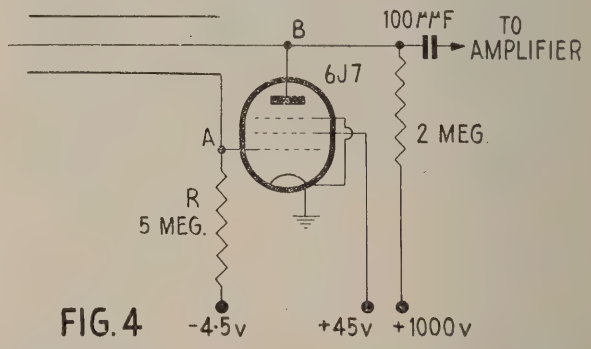


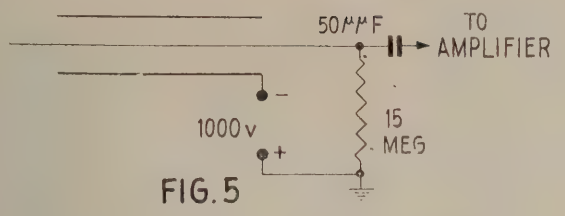
FIG. 4

The Neher-Harper circuit, which has a short recovery period.

When the charge has slowly leaked away, the counter is ready to detect another particle This means that the counter is insensitive for a considerable time after a discharge, and the maximum possible counting rate is limited.

For this reason, vacuum tube quenching circuits with short recovery time are often used. These are of many types. The Neher-Harper circuit is shown in Fig. 4. The 6J7 tube is normally not conducting and the full voltage is applied across the counter, but if a discharge occurs, point A becomes more +ve., the tube conducts, and point B drops to a low potential. This prevents a second discharge, but as soon as the charge leaks off the grid through the comparatively low resistance R, the tube recovers its sensitive condition.

A third method of preventing multiple discharges is to incorporate in the gas filling of the tube a small amount of organic vapour, such as alcohol or ether. This forms a molecular layer on the cathode which prevents the ejection of secondary electrons. These, commonly known as self-quenching counters, work well with the simple circuit of Fig. 5, and

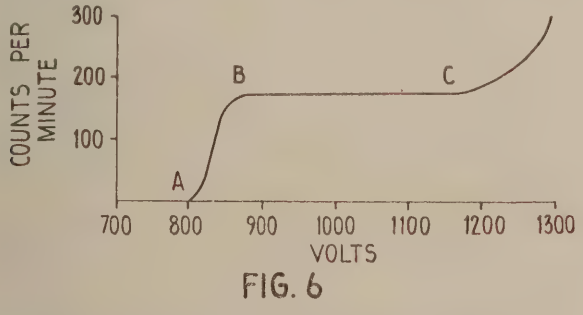


The circuit used with a self-quenching counter-tube.

are very convenient for light portable apparatus, but are not as accurate as the externally quenched type, as their characteristics change slowly with time.

Fig. 6 shows a typical characteristic curve of a counter. It is a graph of counts per minute, against voltage, the intensity of radiation being kept constant. Up to the point A, no counts occur. Then from A to B the counting rate increases rapidly. The region B to C is called the "Plateau' 'and is the range of voltage over which the counter will give reliable results. Above C spurious counts start to appear. These are discharges which occur spontaneously, causing the counting rate to rise.

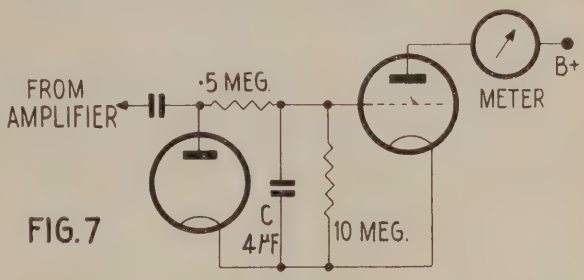
The design of counters varies considerably according to the type of radiation they are to detect. The commonest type is the γ ray counter. As γ rays have great penetrating power, these can be built with thick walls, and, in use, are often enclosed in metal cases. The direct ionizing effect of γ rays is so small that, by themselves, they would very seldom produce a count, but in passing through solids they can eject electrons, or secondary β rays. These are produced from the metal of the cathode and cause



Characteristic curve of a counter-tube, showing the range of applied voltage over which reliable results may be obtained.

a discharge. A counter for β rays must have part of its walls very thin to allow the particles to pass through. This type of tube has thin glass walls, and a cathode in the form of a copper spiral, which form also reduces the response to the γ rays. For cosmic rays a counter similar to those for γ rays is suitable, as cosmic rays are also of high penetration. In this application two or more counters are often used together with a "Coincidence" circuit, which records a count only when they all discharge simultaneously. This gives a directional effect, as a particle must pass through both tubes, to be recorded.

There are two systems commonly used for recording the pulses. Where only moderate accuracy is required, and the counting rate to be measured does not vary over wide limits, the Counting-Rate-Meter is useful. Fig. 7 shows the basic circuit of this. The pulses from the G.M. tube are applied through an amplifier or, more commonly, a trigger circuit, to a diode. The rectified current is used to charge a condenser C. This has a high resistance across it, and the voltage it finally reaches depends on the rate of arrival of pulses. This voltage can then be applied to the grid of another tube, with a meter in the plate circuit, calibrated to read counting rate directly. As the pulses do not come at a regular



The basic circuit of the counting-rate meter. Though useful, this circuit does not give as accurate results as an electro-mechanical counter operated by the Geiger-Mueller tube.

rate, but are spaced at purely random intervals, it is necessary to use a large condenser to smooth out the variations in counting rate, and give a mean value. This means that the meter takes some time to come to its final reading. At about 200 counts per minute, it may take up to three minutes to come to rest.

In laboratories and factories where radioactive materials are used, a circuit of this sort can easily be arranged to give an alarm if the radiation reaches a dangerous intensity.

A system giving greater accuracy and able to handle a wider range of counting rates, is the mechanical counter. This is essentially an electromagnet energised from the pulse amplifier, and driving a pointer round a dial by means of a ratchet mechanism. These can be made to count up to 60 pulses per second and more, but of course the maximum average rate on random pulses is much less than this.

In 1946-1947 a survey of New Zealand's uranium resources was carried out by the Department of Scientific and Industrial Research. For this work, portable G.M. counting gear was developed. The photograph shows a prospecting set, weighing about nine pounds complete with batteries and G.M. tube. It uses a counting rate meter circuit. The latest model uses a miniature mechanical counter, made from the movement of a pocket watch. The main difficulty in portable gear is that of obtaining a stable supply of about 1,000v. In this unit, an oscillating circuit steps up the voltage from a 45v. battery to over 1,000v. Miniature tubes are used throughout. The G.M. tube, along with its leak resistance and coupling condenser, is in the brass sheath in the front of the picture.

As well as the applications mentioned so far, G.M. tubes are used in all branches of atomic and

(Concluded on page 44)

TWENTY-FIVE YEARS OF PICTUREGRAMS

By L. T. SARDONE

Whilst New Zealand and Australia have both been waiting for the arrival of Television, at least, for the past twenty-five years, we have had pictures in the air in Australia.

Admittedly these were not moving pictures as with TV, but at any rate they were pictures that travelled long distances throughout the vast Commonwealth.

Thus it was that September 9, 1954, marked the silver jubilee of the Picturegram service of the Australian Post Office.

It all began in the year 1928 when the Australian Post Office, realising that the speedy transmission of pictures over regular telegraph channels had become a practical reality in the United Kingdom, the United States and the Continent, decided to follow suit.

German Telefunken apparatus was purchased and brought out from Germany. With it came Fritz Fleishmann, a young German engineer. During the next few months he, along with Australian technicians, carried out exhaustive experiments between the Sydney and Melbourne G.P.O's.

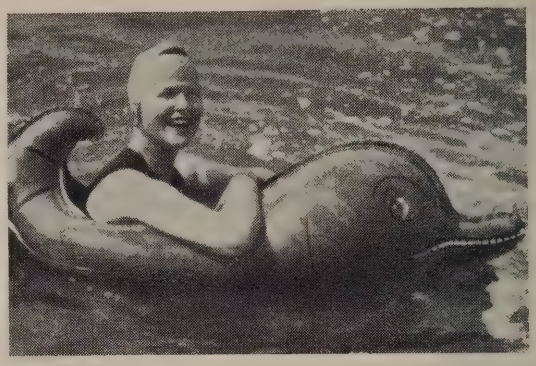
Then came trials, and it is interesting to note that the very first picture transmitted as a picturegram was, appropriately enough, that of the Canberra Post Office.

When the service opened on the morning of September 9, 1929, for the receipt and transmission of photographs between Sydney and Melbourne and vice versa, great competition resulted as to who should have the honour of sending the very first. In fairness to all, the Post Office made no discrimination. However, the first picture to appear in the Press was a photo of the Flinders Street railway station, Melbourne, which appeared in the Sydney Evening News the afternoon of September 9.

Two historic picturegrams of distinction that buzzed along the wires that day were the greetings from J. Garlick, then Chief Civic Commissioner of Sydney, to the Lord Mayor of Melbourne. It ran: "My Lord Mayor. Greetings from the citizens of Sydney to their relatives and friends, the citizens of Melbourne. This is a great occasion—another proof, if proof were needed, that the age in which we live is indeed the Age of Science and Invention. To an ever-increasing extent the powers latent in Nature are being sought out and harnessed for the advance of civilisation and the service of man. Now we have the transmission of pictures and writing between our cities. On the first occasion of this transmission let me send you a message of goodwill and a hope for the continued prosperity of your city. I sincerely congratulate the officers of the Post and Telegraph Department of both Sydney and Melbourne on their fine achievement."

Harold Luxton, then Lord Mayor of Melbourne, replied: "Chief Civic Commissioner, Sydney. Greetings from Melbourne on the inauguration of this important event in the development of communication between our two cities. I hope that the new picturegram service will forge still closer the bonds of friendship between Melbourne and Sydney."

The Post Office, upon inauguration of the picturegram service, soon availed itself of extensive poster and cinema screen slide publicity. The film industry too, was not slow to use this new wonder, and many old-time movie stars had their images sent along the wires. Laura La Plante and Maurice Chevalier were accorded the honour of being among the first picturegrams to appear in an Australian film magazine.



First picture transmitted from Melbourne to Sydney during the 1929 tests, Canberra P.O., was sent from Sydney to Melbourne.

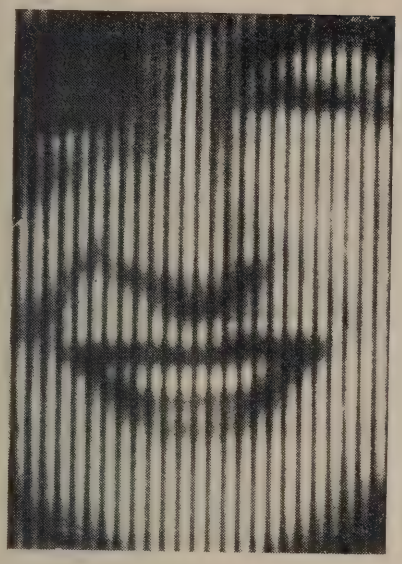
The service caught on very quickly. The Police Departments of practically all Australian States sent finger prints of wanted men over the system, doctors transmitted X-ray prints and were thus able to make quick consultations with colleagues interstate. Artists and architects sent plans and drawings, while advertising agents sent layouts for new advertisements.

It was the Australian Press, however, that immediately realised the immense potential offered by this new miracle. The news value of pictures that could be sent interstate within twenty minutes was infinite.

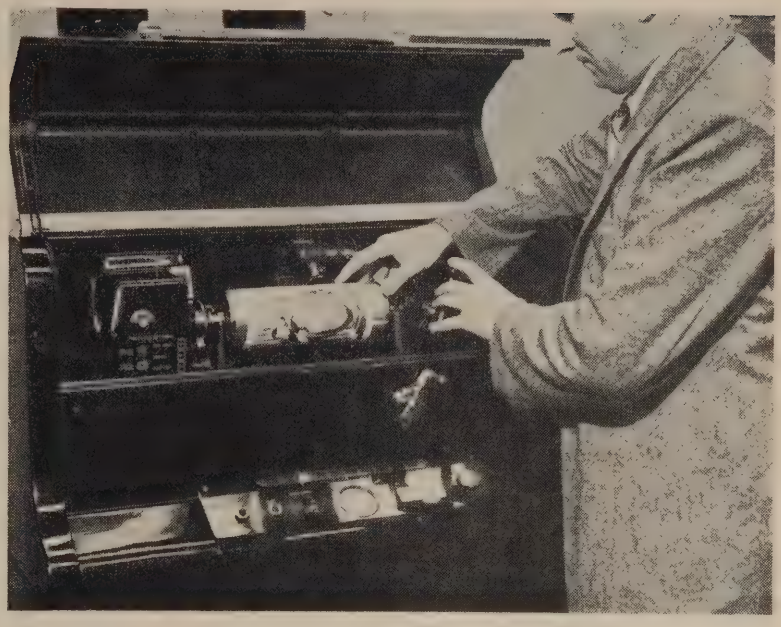
During September, 1929, alone, a total of 127 picturegrams was transmitted; 61 being lodged at Sydney for transmission to Melbourne, and 66 at Melbourne for Sydney. A total of 412 picturegrams was transmitted during the first 10 months the service was in operation. This figure is more to be appreciated when it is recalled that a severe economic depression was then prevailing.

Today, it is quite a different story. More than 12,698 picturegrams were dealt with at offices in the Australian network last year. In addition, 2,410 were exchanged between Australia and overseas. This year's figures, when released (1954-55) will certainly better that.

The service, nowadays, is not limited to Australia. The departmental picturegram network is designed in such a way as to enable the Australian network to be integrated with the overseas phototelegram services, thus permitting pictures transmitted by radio to Melbourne from London, San Francisco, Montreal and Wellington, New Zealand, to be relayed automatically from the radio reception point in Melbourne to all capitals and the city of Newcastle, N.S.W., where required. Only one trans-



About a 10-diameter enlargement of a picturegram showing the scanning lines that compose the picture.



At Sydney G.P.O. picturegram section. Putting a picture on the transmitting drum prior to transmission to Melbourne.

mission of the picture is required and effected, therefore, between the overseas office of origin and the office of destination in any Australian State.

In addition to the overseas places already mentioned, phototelegrams may also be lodged for or received from South Africa, Malta. New York, Belgium, Norway, Finland, Denmark, Greece, Portugal, Switzerland, Federal German Republic, Sweden. Italy. France, Singapore and Japan. Photograms to and from most of these countries are routed via London and, provided radio transmitting conditions are favourable, the principle of automatically relaying the picture signals is observed. It is therefore feasible for a picture lodged in Perth, West Australia, to be transmitted direct to Rome, Italy, without any intermediate handling en route. Most of the foregoing countries have now installed modern Muirhead-Jarvis equipment similar to that now in operation in Australia. This equipment embodies all the latest developments in picture reproduction and enables transmissions to be effected by both frequency modulation and amplitude modulation. It replaced the Telefunken apparatus in 1949.

Greatest demand for overseas transmission and reception came on the occasion of the death of His Late Majesty King George VI. when a total of 281 picturegrams was handled in one 10-day period. The recent Royal visit of 1954 also saw the Commonwealth-wide resources expanded to the fullest.

The time taken to transmit a picturegram varies from six to thirteen minutes, according to the picture's size. Much of modern streamlining is due to the time saved in the developing-printing processes which take approximately the same time as the transmission, by the use of a quick-acting fixing compound which reduces the normal processing period greatly.

Picturegram speed was ably demonstrated when a group of distinguished guests recently visited Sydney G.P.O. on an inspection tour. Photos of the guests were taken and sent over the picturegram circuit to Melbourne and back. Prints from both the original and the picturegram negatives were available at the Sydney G.P.O. before the men left the building.

It is nothing unusual nowadays for the results of interstate sporting events to appear within an hour or two of their happening. However, it did come as a real thrill for Sydney folk when a picture of the first Melbourne Cup finish to be picturegrammed back in 1930 appeared in Sydney papers the same evening at around 5 o'clock, and screen slide picturegrams appeared on leading picture theatre screens by 5.30 p.m.!

The latest picturegram development came in 1953, when Muirhead-Jarvis designed a mobile transmitting unit. Press photographers are now able, with the co-operation of the postal department, to send "on-the-spot" pictures from centres other than capital cities, to their offices direct.

A still further development to the portable transmitter for Press work is the use of privately-owned picturegram apparatus over departmental trunk-line channels subject to certain conditions. Altogether, eight metropolitan newspaper organisations in Sydney, Melbourne, Brisbane and Perth have taken advantage of this arrangement and are at present effecting direct transmissions between newspaper offices. In this way, the newspapers concerned send and receive photos direct from their offices without the need of lodgement at a post office. This still further cuts down time, so vital in Press work.

The magical process of turning pictures into sound at one end of a telegraph or telephone line, and resolving the sound back into pictures again at the

receiving end, can briefly and non-technically be explained as follows.

The picture being transmitted is mounted on the outer surface of a cylindrical drum. A small spot of light is then focussed on the picture at the commencing point, the drum being rotated at a uniform speed by a small electric motor. At the same time, the drum moves slowly in an axial direction so that the spot of light will successfully illuminate every part of the picture. This light is reflected from the picture through an optical system, the reflection varying according to the light and shade of the picture. The varying intensities of light are converted by a photo-electric cell into corresponding fluctuations in electric current; the black portions giving minimum current, the white, the maximum current.

At the receiving end, a sensitised photographic film, on which a pinpoint of light is focussed, is placed on the receiving drum. The intensity of the spot of light varies in accordance with the fluctuations of the incoming current signals from the picture on the transmitting drum. The film is then developed with normal photographic compounds in a dark room and prints taken.

Three sizes of picturegrams are available to the public for interstate transmission. These are the 4 in. x 4in.; 7in. x 5in., and 7in. x 10in., and the charges are respectively 30/-, 35/- and 40/- for a medium grade reproduction. For a fine grade reproduction the charges are respectively 35/-, 45/- and 60/-. All picturegram traffic is handled without delay, and something of a record time was established when a photo lodged at the Sydney G.P.O. was transmitted to Perth G.P.O. and delivered to an address in that city within 30 minutes.

Whilst credit is due to all technicians of the Australian Post Office for the present high development and success of the Australian picturegram service, special mention may be made of Mr. F. C. Barnes, who was the first man to transmit a picturegram in Australia and who figured prominently in the 1929 tests with Fleishmann. Honour also goes to Roy Burgess, a young English engineer in the employ of a Sydney newspaper whose untiring efforts in the field of Press picturegrams has been most noteworthy. His work in connection with the 1954 Royal visit was outstanding.

What of the future? If one were a Jules Verne or a Nostradamus, one could, no doubt, see more mysteries of the future in the fields of picture transmission, radar, TV, micro-waves and a host of other means of communication.

But, gazing into the crystal ball, we see perhaps less than another 25 years, further marvels in store for peoples everywhere. Telegraphic facsimile transmissions of documents, handwriting, typewritten reports from office to office of business executives (already being done in the U.S.), micro-wave systems for sending hundreds of messages simultaneously, cruising cars to receive messages by radio from post offices for instant delivery "just around the corner." We may visualise even whole pages of printed newspapers—photographs and all—flashed over hundreds of miles in a matter of seconds.

All these and many more will doubtless be commonplace in Australia and New Zealand before Australia celebrates the golden jubilee of picturegrams—pictures with wings.

Print of a picturegram recently sent from Melbourne to Sydney.

BINDERS FOR "R. & E."

These are available to hold 12 issues—price 5s. 6d.

PYE LIMITED, ENGLAND

CHAIRMAN'S REPORT AND ACCOUNTS

"We look back with pleasure over some of our achievements during the year," said Mr. C. O. Stanley, C.B.E., Chairman of Directors of Pye Limited, Cambridge, England, at the Annual Meeting of the company recently. "Probably one of the most difficult fields in the world is the manufacture of the television camera and its associated transmission equipment; yet we have supplied equipment for television studios and outside broadcast units for Norway, Belgium, Italy, Switzerland, Japan, United States, Canada, France, Denmark, Germany, Morocco and Great Britain. During the year we gave an experimental broadcast in colour of the Coronation from a position outside the Abbey to London hospitals and we were particularly pleased that some of our cameras were actually used to provide the B.B.C's. Coronation broadcast.

"We have entered several new fields with new scientific instruments and the most famous scientific centres over the world have adopted our new equipment. We broke ground in a new field when we provided the communications for the Everest expedition. It was an honour for us to provide the ship-to-shore communications in the "Gothic" during the Commonwealth tour of Her Majesty the Queen and H.R.H. the Duke of Edinburgh. Our underwater cameras were intensely successful in finding the wreckage of the Comet after the shocking disaster at Elba. In the electrical appliances field the introduction of several new lines has tended to overcome the contraction that took place in the export market a year ago.

"Our receiver sales have increased enormously and in the export market we reached the highest figure we have yet attained. It is interesting to note that in the year 1938/39 our export turnover was only £32,000. This year it is well over £2½millions.

"It is difficult to talk about the future and it is a foolish thing either to make promises or to build up hopes. Despite the competition which has now become very severe in the export market, our figures are already slightly ahead of last year's, and in the home market, up to the time of writing this report, our television and radio set sales are in advance of the great figures we achieved in the Coronation year.

"We have entered two or three new fields, all of them interesting, and we hope they will become profitable, but it is too early to make any material pronouncement. Finally, let us say we have built a strong yet flexible organization, full of courage and determined to deal with any situation that may arise."

Referring to the figures in the accounts, Mr. Stanley went on to say: "There is a most satisfactory increase in net profits before taxation from £743,973 to £1,127,886. The charge for taxation and in particular for Excess Profits Levy is increased because of the increase in profits. The removal of the Excess Profits Levy should considerably lighten the taxation burden to be borne next year.

"Amongst the appropriations which your Directors recommend you will notice an increase in the amount allocated to Employees under our Profit Sharing Scheme which is now £35,000.

"During the year an Award of £20,000 was made by the Government in respect of wartime inventions and this was distributed amongst the individuals responsible for those inventions. At the time this was announced I stated that with the approval of the members of the Company your Directors proposed to allocate a similar sum to the Pye Trust Fund for the benefit of employees generally. This is the sum which now appears as a new item under the recommended appropriations. The Pye Trust Fund exists to help employees both past and present and their dependents who are in need. As the business of your Company continues to expand the demands upon the Pye Trust Fund increase more and more, and this sum of money will be a tremendous help to the Trustees in the good work they are doing."

Pye Limited and Subsidiary Companies Consolidated Balance Sheet comparisons for the year ended 31st March.

LIABILITIES

	1954	1953
	£	£
Share capital issued	1,851,912	1,502,862
4½% Ten-year notes 1954/59	500,000	500,000
Capital reserves	64,974	314,237
Revenue reserves	977,663	904,265
Set aside for future income tax	679,358	434,159
Outside shareholders' interests	11,554	12,297
Creditors	2,752,015	1,912,820
Taxation provision	446,602	357,516
Overdraft	153,641	157,026
Dividends recommended	108,835	73,932
Profit sharing	36,000	26,178
	7,581,554	6,195,292

ASSETS

	1954	1953
	£	£
Land, buildings etc.	918,952	918,821
Tools, jigs etc.	59,658	37,189
Goodwill and trade-marks	160,571	121,950
Trade investments	232,070	249,124
Stocks and work in progress	3,840,552	2,606,210
Debtors	1,958,285	1,864,799
Due under hire-purchase	224,332	198,735
Cash at bank	187,134	197,464
	7,581,554	6,195,292

Dividends for the year absorb £242,883 and the carry forward is increased from £796,694 to £970,137
Profits and dividends for the Pye group of companies for the last seven years are as follows:

31st March	Profits	Preferred dividend	Preferred ordinary	Deferred ordinary	"A" Deferred ordinary
1948	262,807	—	15,000 (10%)	54,017 (25%)	
1949	271,336	—	15,000 (10%)	54,017 (25%)	
1950	400,559	—	15,000 (10%)	75,624 (35%)	
1951	536,930	—	15,000 (10%)	77,784 (18%) A	
1952	611,039	43,531 (5%) B	15,000 (10%)	78,131 (18%)	
1953	743,973	37,500 (5%)	15,000 (10%)	126,922 (20%) C	
1954	1,127,886	37,500 (5%)	15,000 (10%)	126,922 (20%)	63,461 (20%) D

A—100% Free Bonus Shares Issued January, 1951.

B—£750,000 Preference Capital Issued February, 1951. Dividend covers approximately 13½ months.

C—Bonus Shares Issued November 1952 and Additional Capital subscribed December, 1952. Capital ranking for dividend £634,608 includes further capital issued after 31st March, 1953.

D—Bonus Issue of £317,304 "A" Deferred Ordinary Stock December, 1953.

P.B.A.

RECORD TALK

By JOHN GRAY

Festival Records have announced further new popular releases stemming from the American Bell and Coral catalogues, of which two extended play 78s are worthy of note. By purchasing EPM 402 you secure "Secret Love," "Little Things Mean a Lot," "Jilted" and "It Happens to be Me," all on the one disc, and sung by Helen Forrest, Cab Calloway, and Lynn Roberts, in that order. The accompanying bands include those of Sy Oliver and Tommy Dorsey. EPM 411 has a collection of Artie Shaw numbers, doubtless released to coincide with his recent Australian tour. Among the 10-inch LPs there is an assemblage of "evergreens" played by the Red Norvo Trio on CFR10-362, and an attractive-looking disc by the Ames Brothers (CFR10-373) which is well described by its overall title "Till we meet again". Admirers of George Gershwin's tunes—arguably the best written by an American popular composer within the last thirty years—will be interested in Jimmy Dorsey's selection of eight, including one or two rarities, on CFR10-378.

Radio Corporation, who market Capitol records in addition to their own Tanza line, have made quite a song about Capitol CP 297—Gloria Wood's renderings of "By the Waters of Minnetonka" and "Hey Bellboy". They compare her with Yma Sumac and talk about a "fantastic sound"—how right they are! Somehow I think buyers will be more amused by Red Ingle's outrageous versions of "Temptation" and "Cigarettes, Whiskey", obtainable at last on CP 313. Similarly, Tennessee Ernie's "Mule Train" (CP 312) though hardly new, has long been sought by local fans who may now go ahead and buy. On Tanza Z230, Jack Christie returns to the microphone with "The Kid's Last Fight" and "They Made Me Fall in Love With You." One of the first Tanza artists, Jack has latterly been in charge of the record branch of Radio Corporation, which post he is now relinquishing. Thus his many friends will regard this new disc as a passing salute to the industry he has served so well.

Some of us had been wondering if and when Radio Corporation proposed to tap the vast resources of Capitol's classical catalogue. A small and welcome start has been made with the appearance of some releases by the Indianapolis Symphony Orchestra, the latest of which offers four of Dvorak's Slavonic dances done in dashing style (CLC 004).

On the HMV front, the most interesting news concerns the launching of their new extended play 45s. These are the same size as before, with the "optional" centre featuring the small spindle hole, and give approximately twice as much music as previously. Prices are reasonably competitive. A top category HMV or Columbia sells at 15s. and contains as much music as you would have on two normal 12-inch discs selling at 9s. each. Most of the first release has previously appeared in 78 form but there are several new items.

HMV's latest consolidated LP release is again a bumper issue. Their "Il Trovatore" (ALP 1112-3) has the field to itself and is actually the first complete recording of this opera to be released here in almost 25 years. Apart from that it deserves attention on its own account, since the international cast (a Yugoslav soprano, Italian mezzo, Swedish tenor, American baritone and Greek bass) are in magnificent form throughout and the support of the Robert Shaw chorale and RCA Victor Orchestra are all that could be desired. Jussi Bjorling's Manrico is alone worth the price of the whole performance, and for those who like their money's worth, the four sides play for very close on two hours. Many of the same singers may also be heard in "Cavalleria Rusticana" and "Pagliacci", conveniently coupled on a further three discs, ALP 1126-8.

Among the less familiar classics, Toscanini conducts an astonishingly successful version of Beethoven's Septet coupled with a fine Cherubini symphony (ALP 1106), and for modern devotees, Bartok's violin concerto as played by Menuhin (ALP 1121) is a vast improvement on the previous Decca recording.

The Columbia list contains a further operatic gem—Humperdinck's "Hansel and Gretel", recorded in faultless style by German singers headed by Elisabeth Schwarzkopf, together with the Philharmonia Orchestra and an English girls' choir (33CX 1096-7). Schwarzkopf leads also in Lehar's entrancing "Land of Smiles" (33CX 1114-5). In different vein there is Dame Myra Hess playing Mozart's Concerto in E Flat K 271 with Pablo Casals conducting the Perpignan Festival Orchestra (33CX 1091). Like many made under improvised "festival" conditions, the recording is far from ideal and the performance has been criticized as being rather on the slow and serious side, but to me it is one of the truly great Mozart performances. But HMV have no consideration for our pockets this month. In addition to all of the above, they have deluged us with another "Carmen," the cast headed by Rise Stevens and Jan Peerce (ALP 1115-7), Bach's B Minor Mass conducted by Karajan (33CX 1121-3), the magnificently flamboyant Third Symphony by Saint Saens (33CX 1116)—try this on your friends who like good tunes and lush orchestration! and "The Importance of being Earnest" (22CX 1126-7) with a cast headed by Sir John Gielgud and Dame Edith Evans. Then there are two hefty Decca sets—Gregorian Chant on LXT 2704-8 and the 1953 Bayreuth "Lohenghim" on LXT 2880-4. Nowadays there are almost more classical issues in one month than we had formerly within a year. Frankly I cannot decide whether this is or is not a good thing.

Festival Records have further complicated the issue by bringing out a substantial list of Vox classical releases, including a very

(Continued on page 54).

ELECTRICAL AND TRADE SECTION

SPACE HEATING

By Janus

Editor's Note: The term "space heating" is one which has a very broad connotation. It embraces all possible methods of raising the temperature of a given enclosed space, whether by means of an open fire, by gas, or electricity. In this article, our contributor explains in simple terms some of the physical bases of the problem in such a way as to lead up to further articles dealing with the electrical methods of accomplishing space heating.

Animals adapt themselves to their environment by a process of selective breeding. Thus has the polar bear developed a thick furry coat which enables him to be at his ease on an iceberg, while a duck has developed the oily plumage which enables him to disport himself in the water with little fear of consequences. Man has gone one better than these, because he takes his environment with him. The members of the Caucasian race (which includes the majority of white New Zealanders) are comfortable, and indeed able to survive, in only a very limited type of environment. The science of space heating is concerned with providing the correct range of temperature for comfortable survival in our homes, offices, shops, and factories.

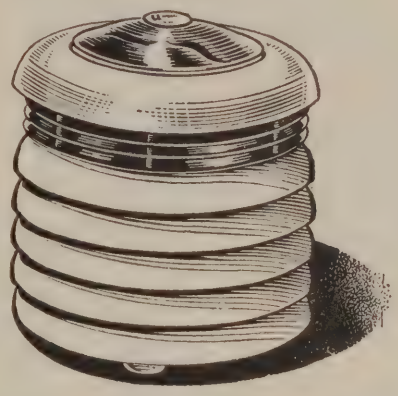
PREFERENCES IN HEATING METHODS

To most of us, and to the majority of our potential customers, the assurance of a comfortable temperature in the home, during the winter months, is of prime importance. In considering space heating in the home, we are immediately faced with personal foibles, and the strong regard for traditional ways of carrying this out. It is seldom that a person considering the installation of space heating apparatus goes seeking advice with a perfectly open mind. Usually, there is present a strongly preconceived notion of what is wanted. Provided this notion is soundly based, knowing what he wants is an advantage to the customer, since it enables him to satisfy his need in the shortest and most direct way. Either for ourselves, or on behalf of a customer, it is unwise to select heating apparatus without a clear idea of what is wanted, for doing so often results in blame for the apparatus when expectations of success are not realized in practice. It is a wise dealer in space heating apparatus who learns enough about the general and particular problems involved, to be in a position to assist his customers, and therefore himself, with sound advice.

THE PLACE OF ELECTRIC HEATING

Space heating by electricity has a number of advantages over other methods, and there is a large and ever-growing demand for the various types of electric heater for use in all fields. Whereas electric lighting became pre-eminent in its field with astonishing rapidity, the same is not true of electric heating, for it faces competition from many other methods of providing warmth and comfort.

Strangely enough, it is in the country districts that there is likely to be the greatest demand for over-all electric heating within the home. It is not so many years since solid-fuel burning appliances—wood ranges and open fireplaces—were the only means of heating farm dwellings. This was in the days when the farmer had access to plentiful supplies



of wood, within easy reach of the homestead, and when he was not so beset with labour troubles that he could not afford to release either himself or his farm workers for the gathering of fuel. To-day he is in a worse position than the urban dweller. The majority of farmers to-day must buy their supply of wood and coal from the towns, and then cart it to the farm. With the high prices of farm produce to-day, the farmer is in a position to invest in other more convenient methods of space heating. Thus country dealers, even more than their confreres in the towns, should be alive to the possibilities, and really push the advantages that electric heating offers over all other methods.

TEMPERATURE AND QUANTITIES OF HEAT

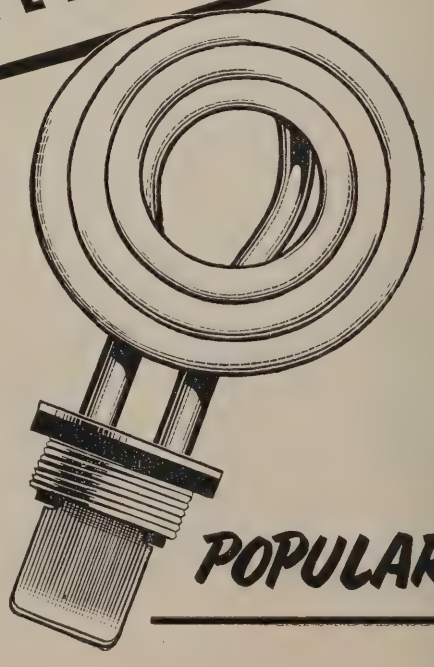
It has been determined that an average human being, wearing a normal amount of clothing, and living in the Temperate Zone, is most comfortable when the temperature of his surroundings lies between 63 degrees and 68 degrees F. Let us consider just what this means. In New Zealand, we use the Fahrenheit scale of temperature for most every-day purposes. On this scale, the freezing point of water is marked 32 deegrees, and its boiling point, 212 degrees. When we say that a temperature range lies between 63 and 68 degrees F., we mean that the surroundings of a thermometer have a temperature of some 30 degrees F. above the freezing point of water. This figure, however, gives no indication of the *quantity* of heat present. To express this, we need a different unit. This can be realized when it is remembered that a thermometer will read the same, if placed in a cup full of water, or a bucket full, provided they are at the same temperature. If temperature was a measure of quantity of heat, a ther-

It pays to stock

- More people ask for EUTRON by name than any other brand. Improved insulation and earthing make EUTRON the safest and most reliable element to recommend.
- Advertised over 11 radio stations throughout New Zealand and sold only through legitimate retailers.

Manufactured by ELECTRIC UTILITIES CO. LTD., 316 Great North Road, Grey Lynn, Auckland, W.2.

(Subsidiary of Nicholson's Holdings Ltd.)



CASH-IN ON EUTRON POPULARITY

mometer would read lower in a cup of water drawn from a bucket, than it would in the bucket itself! The unit by which amounts of heat are measured is the British Thermal Unit (B.T.U.), and is defined as the quantity of heat required to raise the temperature of one pound of water from 39 degrees F. to 40 degrees F. It is a matter of common observation that it takes longer, with a given heating appliance, to boil a bucket of water than a cup full. The appliance gives off the same amount of heat per minute at all times, so that it must require a larger quantity of heat to boil the larger quantity of water. AND THIS IS TRUE IN SPITE OF THE FACT THAT BOTH THE BUCKET AND THE CUP ARRIVE AT THE SAME TEMPERATURE IN THE END.

In heating anything by electricity, it is of interest to know how much heat a given quantity of electricity can generate. One kilowatt-hour (i.e., the so-called Unit, by which electricty is measured for purposes of payment) if converted entirely into heat, produces 3412 B.T.U. of heat. Relating this to the definition of the B.T.U., it is clear that one kilowatt-hour will raise the temperature of 3412 pounds of water by one degree Fahrenheit.

In space heating, we are interested not so much in the temperature rise that can be produced in so much water by a given amount of heat, but rather in what can be done to the temperature of a given mass of air. With air, the relationship is not so simple, but it is reasonable to say that 1000 B.T.U. will raise the temperature of 1000 cubic feet of air by 50 degrees F. Owing to draughts, and the fact that a room is not airtight, it has been found that one kilowatt hour of electrical energy should raise the temperature of a room of 1500 cubic feet by approximately 50 degrees F. It is important to realize, however, that this is not an entirely practical figure, and, for reasons which will be shown later, a one kilowatt heater, if run for an hour, will not actually produce this amount of temperature rise in a 1500 cubic feet room.

It might be supposed that, knowing the amount of electrical energy required to raise a certain volume of air by a given amount, it would be a simple matter to heat any required space by installing heaters up to a loading calculated by simple proportion. Unfortunately,nothing could be farther from the truth. It is necessary to consider several factors before an estimate can be made, and a first essential is that some of the fundamentals of heat be understood. Heat is a form of energy, and is transferred from place to place in three distinct ways, all of which are of importance in space heating, as we shall see.

CONVECTION

The first way in which heat can be transmitted is by convection. It is well known that when bodies are heated, they expand. When this happens, a certain mass of material occupies more space, which is another way of saying that the material now weighs less per unit volume than it did before it was heated. Thus, if the body concerned is a gas or liquid, the warmer parts are lighter, volume for volume, than the cooler parts, and so float upwards. Let us take as an example, some water being heated in a kettle over a gas flame. The bottom of the kettle is heated through being in contact with the hot flame, so that the bottom layer of water is heated, expands, and becomes less dense than the unheated water above it. Being lighter, the warmed water rises, so that cooler water moves in to occupy the space previously filled by the warmed water that has risen. This cool water in its turn is heated and tends to rise also, so that a system of currents is set up in the body of the water, with the warm water rising and cooler water falling to the bottom. These currents are termed convection currents, and by their agency, the water becomes heated through much more quickly than if the currents did not exist. A favourite experiment for demonstrating these currents in water is to drop a few crystals of potassium permanganate (Condy's crystals) into the bottom of an open pot; when the pot is placed over the source of heat, the convection currents start, and can be traced by the movement of the strongly coloured material, which is carried through the water by them.

When the air in a room is warmed, this takes place mainly by convection. The warm air in contact with a heater becomes lighter, and rises, while the cold air moves in to take its place, and is in its turn heated also. The more heat is absorbed by the air in contact with the heating element, the lighter it becomes, and the faster it rises, which means that the velocity of the convection currents is greater. The temperature of the air being heated will largely depend on the length of time it is in contact with the heated surface, so that the velocity of convection currents will be greater when the heating surfaces are tall vertical ones, rather than short, horizontal bars, as in an ordinary household radiator.

This is the principle on which the typical convection heater works, being a rather slim vertical column, with a heater inside it so that the air enters at the bottom, to become heated, and rise with sufficient velocity for the air to be deflected and directed into the room. Alternatively, the heater may consist of a large flat vertical surface, very often fluted, to provide a greater area for contact with the air. The air rises, parallel with the surface of the heater, forming convection currents which in time heat all the air in the room. Moving air in contact with hot surfaces is heated only to a depth of about an inch, so that even a small room will require an appreciable lapse of time before the convection currents can diffuse warm air through the whole room.

FORCED CONVECTION

So far we have spoken only of heaters which rely on natural convection currents, but a second type of heater, which is fast gaining in popularity, is the forced convector heater. In this type, an electrically driven fan forces a current of air across a heated surface, and having heated it, shoots it out in more or less horizontal streams into the room. The scheme has the advantage of heating all the air in a room much more rapidly than does natural convection.

CONDUCTION

The second way in which heat is transmitted is by conduction. If one side of a metal plate is heated, the other side almost immediately rises in temperature too. However, if one side of a fire-brick is heated, the other side is not affected for a very long time. Heat is transmitted through metals similarly to the way in which they conduct electricity and in general it is found that those metals which are good conductors of electricity also transmit heat the best. Silver, which is the best electrical conductor is also the best conductor of heat, and copper is almost as

good as silver for both forms of conduction. However, for non-metallic substances, this is not universally true. Among the many exceptions is glass, which, while being a very poor conductor of electricity, conducts heat much more quickly than, say, brick or wooden walls. Heating by conduction is important in cooking utensils, heating pads, and hot water bottles, but is not important in space heating, except insofar as the heat arising inside the heating apparatus is transferred to the surface, and to the surrounding air.

The most prolific *loss* of heat from a room is by conduction through the walls, ceilings, and to a lesser extent, the floor. In this respect, the space heating engineer would be much better off if heat was not transmitted by conduction, for elaborate precautions have to be taken, especially in colder overseas countries, to insulate between floors, and on top of the ceiling in order to reduce this heat loss.

RADIATION

The third, and possibly the most important way in which heat is transmitted is by radiation. A hot surface will radiate heat energy in a form very similar to light. In fact, heat is produced by almost all light-emitting bodies, and differs from visible light only in that its wavelength is longer. The infra-red rays one hears so much about are nothing but radiant heat. Like light, this radiant heat energy travels in straight lines, and can be both reflected and refracted in the same way as light. For instance, an infra-red lamp is usually provided with a gold or rhodium reflector. All surfaces, whatever their temperature, emit radiation, the amount sent out being proportional to their temperature, and to a lesser extent being dependent on the colour and nature of the surface. Dark-coloured surfaces will emit more radiant energy than a bright or shiny surface. An example of this is the silver teapot, which stays hot longer than a china one, because the shiny metallic surface radiates heat less quickly. This might seem to be in direct contradiction to the so-called "radiator," which has a shiny reflector. Strictly speaking, this is not a radiator at all. The hot element in front of it is the radiator, and the reflector merely re-directs that part of the heat that would otherwise be radiated away from the direction in which the heat is required.

It is important to note that radiant energy will pass through the air without appreciably raising the temperature of the air itself. A solid body, however, which is at a lower temperature than the object that is radiating the heat, will absorb the radiant energy, and its temperature will rise. This in turn will warm the air that is in contact with the body, by conduction; and the next step is that the warmed air gives rise to convection currents. Thus, it is impossible to separate entirely the three methods of heat transference, although the primary method in use at any one time is usually only one of them, the others being secondary effects. In the class of heaters depending mainly on radiation for their working are included all types of bar-cum-reflector radiators.

(To be continued).

BINDERS FOR "R. & E."
These are available to hold 12 issues—price 5s. 6d.

The Geiger-Mueller Counter

(Continued from page 35.)

nuclear physics, including work on atomic energy; in X-ray work; in some systems of metal testing, using γ rays; and in conjunction with artificial radioactive elements, in the new science of tracer chemistry. A large number of the safety and warning devices used at Bikini depended on G.M. counters. They are also used, more than one might expect, to trace lost radium needles in hospitals.

We have now touched at least the fringe of the subject; an extremely interesting one, and, expanding at its present rate, likely to become more so in the future.

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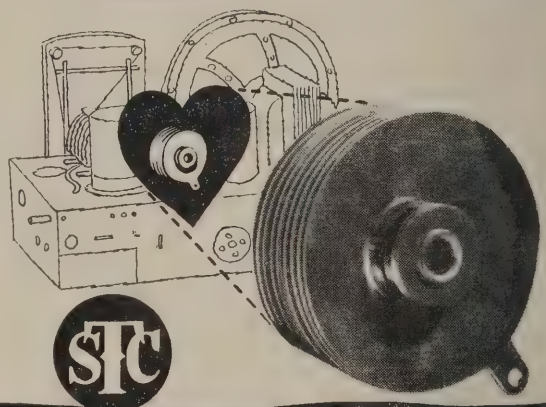

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Radio Manufacturers at the Chateau Tongariro

Annual Conference of the New Zealand Radio and Television Manufacturers' Federation

This year the Radio and Television Manufacturers' Federation held its annual conference at Chateau Tongariro, on 27th and 28th, September. "Radio and Electrical Review" was privileged to be present, as the Federation's official journal, and our representative spent a most interesting two days observing what must be rated as one of the most successful conferences the Federation has yet held.

In the absence of the President, Mr. Ralph Slade, who was travelling overseas, the chair was taken by the Vice-president, Mr. D. T. Clifton-Lewis, who welcomed delegates to the conference, and extended greetings to the representatives of Government departments who were present at the Federation's invitation.

The conference was officially opened by Mr. P. B. Marshall, Secretary of the Department of Industries and Commerce. Mr. Marshall expressed his pleasure in being asked to open the conference, and to sit in on its proceedings. He welcomed the opportunity it afforded him to renew his acquaintance with members of the industry, many of whom he had known and worked with both during and since the war, and he was very glad, he said, to have this chance of learning at first hand of the day-to-day problems of the industry, so that his Department would be the more able to render it assistance in matters where he is able to help. With the ever-growing expansion of the population, said Mr. Marshall, the radio industry should fare well in the ensuing years. He pointed out, however, that the whole western world was heading gradually towards free trade. There was no doubt that such a trend would bring its problems with it. For example, if import licencing for radio receivers was abolished, he wondered whether the radio industry would be able to obtain additional tariff protection in order to offset it. Tariff protection, he said had followed a pattern. In general a tariff protection of 20% to 25% might well remain, but the question is whether that would be enough should import restrictions be lifted. The tendency is for control to be abolished in the cases of the most efficient secondary industries, which are in theory at least, best fitted to cope with overseas competition. Thus, should controls be abolished in the case of the radio industry, manufacturers will in self defence have to see that their productivity is increased by means of increased efficiency in the factories; this, in spite of the high level of efficiency that the radio industry has already reached, being one of the most fiercely competitive secondary industries in the country.

Mr. Marshall stated that rules were now being formulated that would govern the whole flow of world trade. Once those rules had been established their effects would certainly be felt in New Zealand, and we would by then have little opportunity of altering them if those effects did not suit us. Above all, New Zealand must not relinquish the right to determine its own internal policy, and to this end, manufacturers in all industries should get together to establish a united policy concerning the protection to be afforded to secondary industries.

In delivering this warning, Mr. Marshall really started something! The ensuing discussion was very lively, and brought to light some interesting opinions. The consensus of opinion seemed to be that substantial tariff protection would be needed if New Zealand manufacturers were to compete successfully with imported receivers. It was interesting to note the views expressed between the two extremes. Mr. Spencer said he thought that no amount of tariff protection on its own could safeguard the industry, if only because of the impossibly loose way in which the term Current Domestic Value (in the country of origin) could be interpreted by the powers that be. On the other hand, Mr. Heginbotham considered that our manufacturers would have no difficulty at all in meeting overseas competition (dumping excepted) provided a reasonable tariff barrier were erected. Several speakers made somewhat trenchant criticism of the Board of Trade, but more particularly of the way in which it was constituted, and because, allegedly, it was subject to political control.

After starting on the note of higher policy, the conference continued in this vein for some time. After disposing of the routine items, the Vice-President read the Annual Report, which was received with congratulatory remarks, and the conference was well under way, having short-circuited at least one item on the agenda as a result of the spontaneous discussion which arose following Mr. Marshall's opening remarks. The morning ended with almost half of the agenda items dealt with, and lunch was taken with the conference figuratively patting itself on the back for having got away to such a good start.

Two of the high-lights of the remainder of the proceedings were addresses by Mr. N. R. Palmer of the N.Z.B.S., and Mr. G. Searle, of the P. and T. Department. Mr. Palmer took as his subject, "Recent Developments in the Broadcasting Service." He outlined the progress the Service has made in the last three or four years towards improving the coverage in areas that had been hitherto poorly served with broadcast transmissions, and gave a short account of recent technical progress, and how it had benefited the end product, namely the production of programmes. The main items of interest were the use of tape recording, and the putting into service of long-distance telephone lines capable of giving reasonable reproduction of music. The latter development, Mr. Palmer said, had already a pronounced effect on programming, and it was not yet possible to say how far-reaching its effects would ultimately be. Complex terminal equipment had been designed and built by the N.Z.B.S's. own engineers, and the channels were leased from the P. and T. Department. The terminal equipment presented many problems, mainly on account of the necessity for very rapid re-routing of the lines. At one moment, a hook-up might be in progress between the main four commercial stations, while a minute later a completely different connection would be needed involving the National Stations. This necessitated almost instantaneous switching operations of a complicated nature,

so that the old-fashioned methods of using patch cords by hand was quite out of the question. Mr. Palmer also gave a brief outline of some of the difficulties encountered during the Royal Tour. Many of these had to be overcome by means of full-scale rehearsal of the "operation" to be undertaken, he said, and the scale of the outside broadcast arrangements was such as had never before been even thought of in this country. That the many problems were all satisfactorily solved and that not one major break-down in arrangements occurred throughout the whole Tour was in itself a great tribute to the technical staff and to the many commentators involved, Mr. Palmer said.

After thanking Mr. Palmer for his address, the Conference passed a motion of thanks to the N.Z.B.S. for the admirable service it is giving listeners, both technically, and on the programme side. Several delegates spoke to the motion, adding their personal word of congratulation to the Department on a job excellently done.

Unfortunately, at the present juncture, space prevents us from reporting the Conference in its entirety. We have as yet made no mention of many important matters that were discussed, nor have we touched on the most informative address delivered by Mr. Searle, covering the telecommunication developments that have recently taken place in the Post and Telegraph Department. We hope in an early issue to print this address verbatim.

Conference of N.Z. Radio-Television and Electrical Traders' Association

More than 55 dealers representing practically every provincial town in the Auckland district attended the very successful Conference of the N.Z. Radio-Television and Electrical Traders' Association held at Cambridge on 11th September.

While their husbands were occupied by Conference proceedings, members' wives enjoyed the outings arranged by the Social Committee. The Conference concluded with a most successful evening social, and the compliments of the executive go to those who arranged such a happy function.

During the day, addresses were delivered by Mr. T. Clifton-Lewis of Radio (1936) Ltd., on television overseas, Mr. R. Waddell of the Seddon Memorial Technical College on the progress made in the training of TV technicians, and Mr. W. J. Murphy, Vice-President, on the registration of servicemen under the Electricians' Act.

The spirited debate accorded the remits demonstrated the value of conferences in enabling dealers not only to ventilate their individual views, but also to achieve some unanimity in their approach to various factors influencing trading today.

The introduction of the advertising campaign for the sale of car radios was heartily endorsed.

When considering the question of guarantees on radios, the Conference decided that all radio manufacturers be requested to attach to their products a guarantee label with a blank space thereon so that the period of the guarantee could be completed by the retailer at his own discretion.

In view of the unsatisfactory position at present applying to the supply of school radio equipment, dealers are to be encouraged to approach their local M.P.s protesting against the monopoly enjoyed by certain large firms who supply such equipment through the Education Boards, though local dealers are invited to service such equipment.

Frank criticism of the lack of variety of broadcasting programmes resulted in a decision to write to the Minister of Broadcasting drawing attention to the unattractiveness of the National Broadcasting programmes. A report submitted to the Conference claimed that only 20 per cent. of the people listen to other than commercial stations. Hence the extraordinary position has arisen whereby commercial stations, supported by advertising revenue, receive greater listening audiences than the national stations, for the upkeep of which every receiver licensee is compelled to pay 30s. per annum.

Dealing with that hardy annual "radio interference," the Conference instructed the executive to approach the P. and T. Department in an endeavour to secure the enforcement of the Radio Interference Regulations.

Heated argument concerning the supply of component parts finally resulted in a decision to approach the Minister of Customs requesting the abolition of import restrictions on all component radio parts, thereby enabling servicemen and manufacturers alike to obtain more up-to-date equipment at lower cost, with the consequent reduction in the cost of repairs and replacements.

In view of the heavy losses sustained by many dealers through the recent abolition of sales tax on various products, it was felt undesirable to seek the release of radios from sales tax meantime.

After listening to Mr. Murphy's report concerning the registration of servicemen, Conference decided that efforts be made to secure a limited registration for those trained technicians in the manufacturing or servicing industry, so that their services could be retained without their having to qualify by examination. In the meantime, those servicemen not yet registered under the Electricians' Act and in doubt about their eligibility for registration, are advised to communicate immediately with Mr. H. C. McQueen, P.O. Box 6310, Te Aro, Wellington, C.2, for further information.

A remit that "All radio dealers and servicemen be exhorted to maintain the scale of charges as set out in the Guide Schedule now available from the Association", was carried unanimously.

During consideration of profit margins, dealers were informed that actually there had been no reduction in profit margins fixed by the Price Tribunal. However, a number of lower-priced sets were being marketed and offered to the trade at prices which did not maintain the requisite margin. Also, it is apparent that, on ascertaining the retail price, dealers are buying goods from distributors without considering the actual profit margin. Before placing orders, therefore, consideration should be given to the cost price as well as the retail price. Dealers should ensure that manufacturers and/or importers maintain a reasonable mark-up on goods, and where this is too small, disapproval can be expressed by refraining from buying.

On the question of freights, country members explained the disadvantages of the present system whereby they are forced to sacrifice part of their profit margin in meeting freight charges on many proprietary lines advertised through the national press at fixed retail prices. It was considered that some way should be found to protect the profit margin of country dealers, and a special committee was established to investigate the matter.

Mr. R. Waddell of the Seddon Memorial Technical College reported that the Correspondence Section of the Education Department had now agreed to institute a Correspondence Course in TV training. This two-year course to commence in February, 1955, would be designed more or less in a pictorial rather than an academic manner, but all students undertaking the course would be obliged to attend at least one week's practical course at the S.M.T.C. each year prior to being permitted to sit the examination. The course would be open to all those who had not taken advantage of the five years' free secondary course. Probably intending students who had completed five such years would be required to pay a college fee, but this had not yet been determined. However, the College was most co-operative, and from its large lending library on technical subjects relating to radio and TV, books would be available to students. In view of the fact that this was purely an Auckland venture, the total number of students to be enrolled for the first two-year period would be limited to 20, but, in the event of the number of applicants justifying the engagement of further tutors, the College might consider increasing the student intake.

In an extremely down-to-earth address relating to his recent investigations overseas, Mr. Clifton Lewis expressed his opinion that it would be disastrous for New Zealand if TV came here under two years, for the reason that dealers here have had no experience, servicemen are not trained and have not the equipment with which to service sets sold. He pointed out the heavy

(Continued on page 53).

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars contact Advertising Manager, R. & E., Box 8022, Wellington.

"TAYLOR" MODEL 191A WIDE RANGE R.C. OSCILLATOR

Embodying a conventional Wein bridge type of R.C. Oscillator circuit, thermistor stablized to give a pure sine waveform of practically constant amplitude at all frequencies within the range of the instrument, the "TAYLOR" MODEL 191A WIDE RANGE R.C. OSCILLATOR generates sine and square waves of exceptionally good waveform over the wide frequency range of 10 c/s. to 100 Kc/s. It also provides a convenient source of voltage or low power for checking the frequency and transient response of amplifiers, transformers, loudspeakers, etc.

SPECIFICATION

Frequency Range:

(1) 10 c/s to 100 c/s, ± 2%.
(2) 100 c/s to 1,000 c/s, ± 2%.
(3) 1 kc/s to 10 kc/s, ± 2%.
(4) 10 kc/s to 100 kc/s, ± 2%.

Output: Sine Wave.

1 millivolt to 10 volts RMS into 600 ohms load, ± 1 db.

2 millivolts to 20 RMS into high impedance ± 1 db.

1.6 x 10^{-10} watts to 0.16 watts into 600 ohms, load ± 1 db.

Square Wave:

6 millivolts to 60 volts peak-to-peak into high impedance.

3 millivolts to 30 volts peak-to-peak into 600 ohms load.

Rate of rise to 9% of peak, 0.3 microseconds at 100 kc/s.

Output Impedance:

Attenuation:

Accurately adjusted for all outputs to 600 ohms. Fine attenuation calibrated 1 to 10 (20 db), continuously variable. Coarse attentuation in steps giving — 20 db, — 40 db, and — 60 db, with precision matched 600 ohms pads.

Distortion: 1% at 1,000 c/s.

Valves:
2 x 12AU7: 2 x 12AT7: 1 x 6X4.

Power Supply:
105-120 volts, 200-250 volts, 40-100 c/s.

Power Consumption:
70 watts approximately.

The "Taylor" Model 191A is distributed throughout New Zealand by Messrs. A. R. Harris Co. Ltd., P.O. Box 1007, 74-76 Manchester Street, Christchurch, who welcome all inquiries. Retail price £40 8s. 4d.

Missing and Stolen Radios

AUCKLAND:

Five Star battery/electric portable radio, serial No. 43310: black plastic case 16 in. x 10 in. x 6 in., carrying handle on top, full width aluminium fluted grille for speaker, oblong dial with tuning and volume control knob on either side.

OTAHUHU:

Regent model C.P.I. portable radio, serial No. 18938: red metal cabinet.

PALMERSTON NORTH:

Philco AC/DC model 601, portable radio, serial No. 54775: white bakelite case.

Sheffield auto radio, serial No. 2597.

WELLINGTON:

Ultimate AC/DC broadcast portable, serial No. 149508: ivory plastic case 9 in x 6 in. x 4 in., circular dial, two ivory tuning knobs, white plastic handle on top of case.

Pacific model 6P1 portable, serial No. 23709; blue plastic case. Philips 5-valve model 209, serial No. 81743, royalty No. 35254: brown cabinet.

Philips 4-valve mantel model 146, serial No. 4860-68486: maroon bakelite case.

Cromwell 4-valve mantel model 4154, serial No. 33964: red bakelite case.

Sunbeam electric cake mixer, serial No. S.374895: white enamel, complete with two white porcelain mixing bowls.

CHRISTCHURCH:

Ford 12-volt, 8-valve, broadcast auto radio, serial No. 11637: brown, with chrome surround on dial; in three parts, speaker, tone control, and main control—made specially for Zephyr and Consul cars.

Pacific 5-valve auto radio without speaker: grey plastic face, white knobs. Radio longer and heavier than usual.

Rolax 5-valve mantel model broadcast radio, serial No. 6095: brown plastic case.

RADIOS RECOVERED

Ultimate, serial No. 109882.

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P.O. Box 279 — Palmerston North — 323A Main St.

TRADE WINDS

NEW APPOINTMENT FOR MR. C. W. SALMON

One of New Zealand's best known electronic engineers, Mr. C. W. Salmon, Grad.I.E.E., Assoc. Brit.I.R.E., late of Electronic Controls and Appliances Ltd., Auckland, has recently been appointed Assistant Engineer to the Auckland Branch of Messrs. Turnbull and Jones Ltd.

Mr. Salmon is the present Dominion Secretary of the New Zealand Section of the British Institution of Radio Engineers, and, prior to his connection with Electronic Controls and Appliances Ltd., was the Demonstrator in Electronic Engineering at the Auckland University College.

* * *

AUTOCRAT DISTRIBUTORS LTD.

As announced in a special insertion in our October issue, Autocrat Distributors Ltd., of 285 Great South Road, Auckland, have now become the sole New Zealand distributors for Autocrat car radios.

City offices in Auckland are to be opened shortly. Meantime, any written enquiries should be addressed to P.O. Box 2364, Auckland.

At the head of this enterprising young firm are Messrs. R. H. Walker, F. P. Wills and G. S. Benson, all well-known in the radio trade, as is also the new Sales Manager, Mr. Des. A. Taylor, late of G. A. Wooller & Co. Ltd. Mr. Neil Avery, late of H. W. Clarke (N.Z.) Ltd. is the Wellington Representative, and a South Island Representative will be appointed shortly.

Manufacturers of the famous AUTOCRAT car radios, Autocrat Radio Ltd. are car radio specialists, and through their distributors, Autocrat Distributors Ltd., they offer a first-class service to the trade in new sets and matters relating to warranty, besides ensuring prompt retail and service.

At present there are 47 authorised Autocrat Service Agents throughout New Zealand from Kaitaia to Invercargill.

* * *

MR. E. PERNASE.

During the past few weeks Wellington has missed the stimulating presence of one of its leading radio engineers, Mr. E. Pernase, of Amalgamated Wireless (Australasia) Ltd., who, at very short notice, left by air for the United Kingdom to attend special demonstrations of new equipment by the Marconi Wireless Telegraph Company Ltd. During his tour abroad Mr. Pernase will take the opportunity to visit various other overseas organisations associated with A.W.A. Ltd. before returning to New Zealand at the end of the year.

* * *

AUCKLAND VISITORS TO R. AND E.

Smitten by the "Travel Bug," Auckland members of the trade seem to have been roaming the country a good deal of late, and we have been very pleased to welcome to our office Mr. G. A. Wooller of G. A. Wooller and Co. Ltd., Messrs. E. P. Wills and D. A. Taylor of Autocrat Radio Ltd., Mr. S. Pemberton of "Electrical and Radio Trader," and Mr. David J. Reid. The latter was accompanied by Mr. S. C. Davison of Palmerston North with whom he expects to be associated in trading matters in the Wellington Province in future.

A.W.A. DEMONSTRATES NEW R.C.A. TELEVISION EQUIPMENT AT DUNEDIN

Cynosure of all eyes at Dunedin recently has been the R.C.A. television equipment demonstrated by Messrs. Amalgamated Wireless (Australasia) Ltd., under the supervision of Mr. V. R. Ambrose.

Main virtue of this equipment is its reliability and simplicity of operation, while the price of the complete equipment is an added attraction, being under £1,000 for camera, control unit and two monitor receivers. Reliability is proved by the fact that, not once during all the demonstrations was there any hold-up due to technical faults in the equipment.

The miniature R.C.A. industrial cameras used the 6198 photoconductive vidicon pick-up tube. Four stages of video amplifiers were included, together with an R.F. oscillator and modulator tuneable over the American channels 2-6. The cameras were wired to the receivers via 300Ω shielded cable. In all, three cameras and control units were used, together with six R.C.A. 17 HI standard TV receivers covering the channels 2-13 (the American VHF TV Band). The size of the picture tube was 17 inches.

The equipment was used to televise stage shows at the Industrial Fair, where Mr. Ambrose also demonstrated the TV telephone equipment which aroused much interest.

Demonstrations were also given at the Public Hospital and at the D.I.C., thus providing dwellers in that Southern Fastness with a wonderful opportunity to witness the varied scope of television in the fields of entertainment, industry, education (and possibly as an assistant in the course of justice!)

* * *

"INSTRUCTAGRAM" GIVES IMPORTANT VISUAL AID TO T.V. STUDENTS

Although no television service has yet been started in New Zealand, students of Wellington Technical College are being prepared for its advent. Recently two Philips educational devices have been on show at the College to provide instruction on television. Normally these devices are used for teaching dealers' service engineers, but their value to instructors and students in general technical education is now being realized.

Aim of Philips "Instructagrams" is to clarify for the student the practical connection between a theoretical diagram and the function of the particular piece of equipment represented by that diagram. Actually it is a drawn circuit connected to the electrical components it designates.

The "Instructagram" on show at the Wellington Technical College was a small unit illustrating how, in a television set, the shapes of synchronizing and other pulses are altered at will by a combination of condensers and resistors.

One of the great differences between a "Sound" system and a television system is that whereas a "Sound" apparatus is concerned with reproducing A.C. signals, the television system has not only to scan the scene into lines—each of which carries the picture detail—but also to attain faithful repro-

duction of average illumination of the scene before the camera, thus showing whether the scene is a dark or bright one. For this reason the television system has to transmit and receive direct current values as well as a wide band of alternating current frequencies.

The second Philips instructional demonstration makes possible practical instruction of this in the absence of a television service operating in this country. The method demonstrated at the College uses only Philips standard service equipment, thus obviating a camera or other image devices which are expensive to make and costly to run. This is an important consideration when equipment has to be provided for a large number of students.

A Philips standard dealers service variable-bar-pattern generator simulates the condition of varying studio illumination, and the action of the "Synch-separator" and the automatic adjustment of the average "brightness" of the image on the picture tube itself can be examined and checked without the use of costly apparatus. This can be done at any time, irrespective of whether there is a transmission or not—an invaluable advantage to instructor, student and television service engineer alike.

CAR RADIOS

The editorial entitled "Car Radios" published in our September issue has occasioned much comment both for and against our contentions.

Foremost amongst the dissentient voices has been that of the Taranaki Radio Traders' Association, who, in voicing their complete disapproval of our editorial, advance the arguments that:—

"The sale of car radios was not lost to the trade through the attitude of the latter. In fact, some manufacturers have never given the Trade the initial opportunity to market such radios.

"The radio manufacturers of New Zealand, of whom there appear to be far too many, form a protected industry with very little competition from imported sets, and, in some cases, they manufacture sets which fall by the wayside according to the standards of the Trade. To justify their existence new lines are constantly marketed under different names, and dealers are appointed from amongst the rag, bone and greaser trades—people who are interested solely in monetary return and not the welfare of the Trade from the after-sales service viewpoint.

"Some manufacturers sell job lots to automotive firms. In the Taranaki area we have instances of the latter using the cars as a lever to sell the sets (take the set or you don't get the car). In this way they profit from the sale of both the set and the car.

"For purposes of appointing a service agent, manufacturers then approach radio dealers, offering the latter a mere pittance for labour per hour and parts replaced, thus depriving the serviceman of legitimate profit on labour and the spare parts used. In plain language, the whole position with these sets 'just stinks.'

"No doubt, to a certain extent the dealers themselves are to blame on account of the apathy shown towards their own Federation. So long as they refrain from joining the latter, thus depriving the organisation of the support it should have, radio manufacturers will continue to bastardise this section of the trade by offering apples to the radiotricians and bestowing the plums elsewhere.

"Of course, there are some radio manufacturers who definitely stick to the Trade and refuse to depart from this policy. These select few enjoy considerable dealer prestige and do not have to approach outside interests to market their merchandise.

"The radio Trade definitely will undertake the repair of car radios and is fully equipped to do so. It definitely encourages the sale of car radios and is ready to undertake installation of the latter at all times.

"Contrary to your article, dealers do not ask for the set to be placed on the service bench, because, in a number of instances, the aerial could be at fault, and the latter cannot be checked on the dealer's bench.

"In conclusion, may we add that radio dealers will sell, will install and will service car radios providing these are the product of a manufacturer who sells exclusively to the Trade, and that they are sold and installed by a *bona fide* licensed radio dealer."

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FOR THE TECHNICIAN

Service Instructions for the Philips "Philishave" Electric Dry Shaver, Type 7735

(Continued from October, 1954, issue of "Radio and Electrical Review")

Lift the ends of the springs (which hold the carbons in position) out of the slots in the carbon holders, using tweezers. Put the carbons into their holders, and replace the spring ends in their slots.

Solder the mains flex to the coil, and clamp it in position, and fit the anti-interference capacitors, taking care whilst soldering not to overheat the coil, or to allow solder or resin to contaminate the carbon holding springs, etc.

Place the gear wheel assembly in position, taking care to replace the washers (item 14).

(6) Lubricating

Vaseline can be used for lubricating the transmission. The rotor bearing and the Philite gear wheel can be lubricated with a little light machine oil. It is important to see that the carbon brushes are not contaminated with oil. The felt pads in the bearing block may need the application of one drop of light machine oil occasionally.

(7) Testing the Motor

Connect the motor to the mains and allow it to run, at the same time listening for any excessive noise. For comparison, a properly running "Philishave" may be used.

(8) Testing and Spring Pressure

This test relates to the spring (item 11) which keeps the cutter in contact with the head. The efficiency of the shaver is influenced to a large extent by the setting of this spring. Proceed as follows:—

Put the top half of the casing over the motor, firmly pressing the motor into it, but not screwing it down. Put the shaving head cap with cutter onto the hairchamber; but do not fix it with the fixing ring (item 4). Make sure that the coupling pin fits into the opening in the cutter. Now lay a 25 gm. weight on the shaving head. The rim of the shaving head should not then lie on the hair chamber. If it does so, stretch the spring (item 11) slightly, and retest. Then put a 35 gm. weight on the shaving head. This should cause the rim of the head to bear upon the rim of the hair chamber. If it does not do so, compress the spring slightly, and test again.

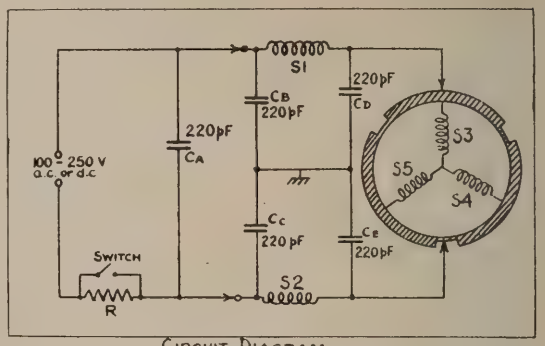
(9) Final Assembly

Screw down the motor into the top half of the case. Screw on the bottom half. Place the hair chamber ring in position, and fit the shaving head, and its fixing ring.

(10) Possible Defects

(a) Motor does not run

Resistor R open circuit.
Stator, or rotor coil open circuit, or short circuit.
Capacitor C_1, or C_2, short circuit.
Mains lead broken.
Carbon brushes badly worn or sticking.
Rotor seized up in the stator opening.
Badly meshing gear train.



CIRCUIT DIAGRAM.

Collector plate fouling brush holders.
Short circuit between commutator segments.

(b) Uneven running

Short circuit in one or more of the coils.
Leaking capacitors.
Bad adjustment of the gear wheels.
Bearings too tight or too loose (rattling).
Brush torsion springs too strong or too weak.
Brush holders too far from the commutator.
(This distance should be 1 mm. when the rotor is pushed to the limit of its axial travel away from the brush holder.)
Wrong type brushes. (It is important that the type of brush specified should be used.)
Dirty and/or sticking brushes.

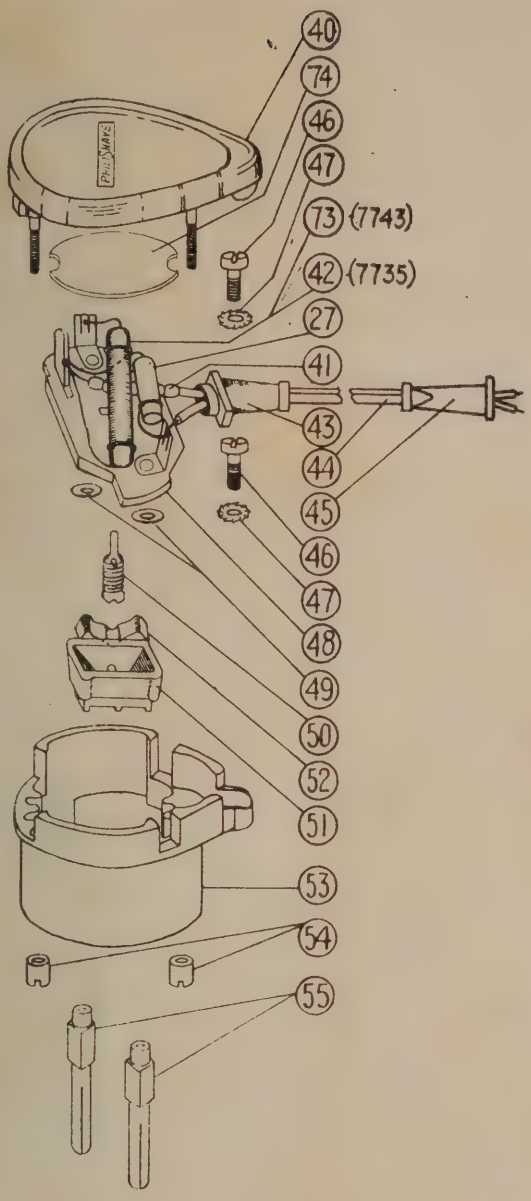
(c) Inferior shaving

Cutter may be inverted.
Faulty adjustment of pressure spring.
Shaving head dirty. (Brush out with a fine brush using alcohol or surgical spirit.)
Shaving head dented or badly worn, causing rattling.
Squeaking may occur if the user has a very dry skin.
Advise him to rub a drop of oil on the palm of the hand, and to hold the shaving head against it with the apparatus running.
Further hints are contained in the instruction booklet supplied with each shaver.

Spares List for Type 7735

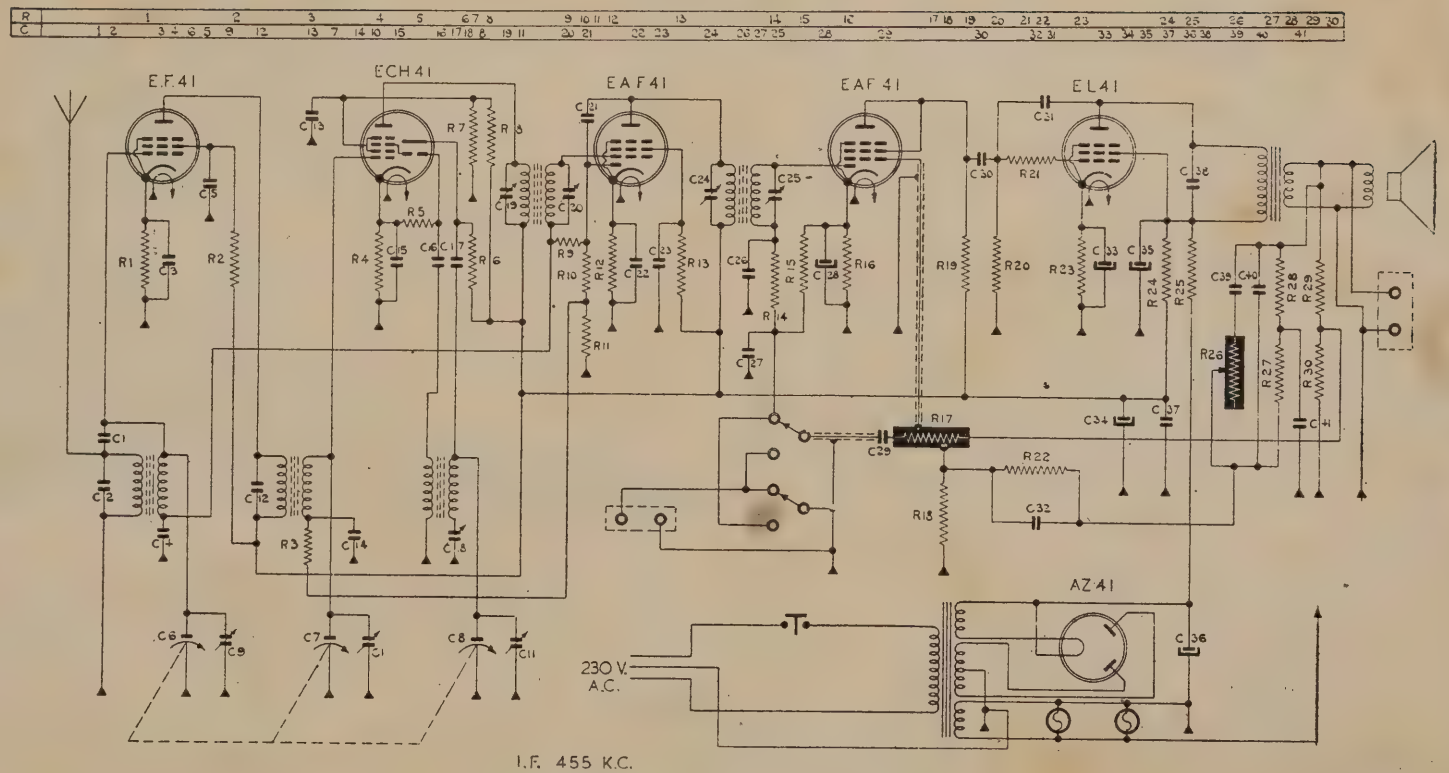
The following is a list of spares for type 7735 with item number and code number:—

1.—Protecting cap, A1.599.12
2.—Oil disc for above, A1.806.65
3.—Cutter and guard assembly, A4.840.70
4.—Ring nut for securing above, A4.330.08
5.—Ring round hair chamber, A4.450.63
6.—Complete casing, 23.631.22
7.—Fixing screw for casing M2 x 12 (2), 07.660.12
8.—Fixing screw for casing M2 x 10, 07.660.10
10.—Spring ring for coupling spindle, A4.450.64
11.—Pressure spring for coupling spindle, A4.600.59
12.—Coupling spindle and pin, HT.822.08



13.—Philite gear wheel, A4.750.18
14.—Bearing washer for above, A4.450.79
15.—Screw for fixing item 16 M2 x 4, 07.800.04
16.—Pinion, A4.450.65
17.—Screw for fixing item 18 M2 x 2 (3), 07.800.02
18.—Rotor bearing, A4.850.03
19.—Frame assembly, A4.800.03
20.—Clamp for mains lead, A4.031.00
21.—Fixing screw for above M2 x 8 (2), 07.800.08
22.—Rubber washer (6), A4.451.21
23.—Washer (3), 07.013.03
24.—Shouldered screw for fixing frame to housing (3) A4.511.58
25.—Rotor, A4.910.05
26.—Stator coil ass., A4.920.12
27.—Anti-interference capacitor, 48.406.10/220E
28.—Screw for fixing stator coil ass. M2.6 x 12 (4) 07.802.12
29.—Bearing block ass. complete, A4.760.13
31.—Washer for item 32, G7.045.40
32.—Fixing screw for bearing block M2.6 x 8 (2), 07.802.08
37.—Carbon brush (2), A4.270.52
40.—Top cover for mains plug, 23.642.79
41.—Insulating bead (4), 56.600.32/50
42.—Resistor 170 ohms, 4 watt, 49.363.46
43.—Grommet for lead (plug end), A4.540.04
44.—Mains lead (2 yds.), 33.999.99/107
45.—Grommet for lead (shaver end), A4.540.03
46.—Screw M2.6 x 6 (2), 07.802.06
47.—Washer (2), G7.045.40
48.—Pax. Plate ass., A4.890.30
49.—Washer (2), 25.438.60
50.—Spring Strip ass., A4.920.21
51.—Voltage adj. slide, 23.735.16
52.—Leaf spring, A4.600.65
53.—Bottom moulding, 23.631.08
54.—Round nut with saw cut (2), A3.315.43
55.—Plug pin, A4.421.21
56.—Weight I. 25 gr., HT.602.05
57.—Weight II. 35 gr., HT.602,06
Bayonet plug adaptor, HT.908.03
Mains plug assembly complete, HT.908.11
Cleaning brush, HT.90200

PHILIPS MODEL 305



C1	3.9 mmfd. ceramic	C14	.05 mfd. 400v. paper	C27	100 mmfd. ceramic	C39	.02 mfd. 400v. paper	R11	1 meg. ½ W. carbon
C2	10 mmfd. ceramic	C15	.05 mfd. 400v. paper	C28	25 mfd. 25v. electro-lytic	C40	650 mmfd. mica	R12	330 ohms. ½ W.carbon
C3	.05 mfd. 400v. paper	C16	50 mmfd. mica			C41	.01 mfd. 400v. paper	R13	100 k. ½ W. carbon
C4	.05 mfd. 400v. paper	C17	150 mmfd. ceramic	C29	.05 mfd. 400v. paper	R1	330 ohms. ½ W.carbon	R14	68 k. ¼ W. carbon
C5	.01 mfd. 400v. paper	C18	400-1000 mmfd. pad.	C30	.02 mfd. 400v. paper	R2	100 k. ½ W. carbon	R15	1 meg. ½ W. carbon
C6, C7, C8	12.5 440 mmfd. tuning	C19	I.F. trim. in I.F. can.	C31	100 mmfd. ceramic	R3	2.2 meg. ½ W. carbon	R16	2500 ohms. ½ W. car.
		C20	I.F trim. in I.F. can.	C32	.02 mfd. 400v. paper	R4	220 ohms. ½ W.carbon	R17	2 meg. vol. control switch & tap
		C21	10 mmfd. ceramic	C33	25 mfd. 25v. electro.	R5	22 k. 1-3 W. carbon	R18	22 k. ½ W. carbon
C9, C10, C11	Trimmers on Tuning gang.	C22	.05 mfd. 400v. paper	C34	20 mfd. 400v. Triple Electrolytic	R6	25 k. ½ W. carbon	R19	100 k. ½ W. carbon
		C23	.01 mfd. 400v. paper	C35	40 mfd. 400v.	R7	47 k. ½ W. carbon	R20	470 k. ½ W. carbon
		C24	I.F. trim. in I.F. can.	C36	40 mfd. 400v.	R8	25 k. ½ W. carbon	R21	22 k. 1-3 W. carbon
C12	100 mmfd. ceramic	C25	I.F. trim. in I.F. can.	C37	.25 mfd. 400v. paper	R9	2.2 meg. ½ W. carbon	R22	250 k. ½ W. carbon
C13	.01 mfd. 400v. paper	C26	100 mmfd. ceramic	C38	.0047 mfd. 400v. "	R10	470 k. ½ W. carbon	R23	150 ohms. 1 W. carbon
								R24	2200 ohms. 3 W. W.W. Bootlace
								R25	2 x 1800 ohms. 4 W. carbon
								R26	.5 meg. tone control
								R27	47 k. ½ W. carbon
								R28	6000 ohms. ½ W. car.
								R29	100 ohms. ½ W. car.
								R30	27 ohms. ½ W. car.

Radio, TV, and Electrical

(Continued from page 46.)

initial costs entailed in the establishment of TV and the specialist services it entailed in the erection of aerials, etc.

After surveying the position most thoroughly, Mr. Clifton Lewis considered that TV must come to New Zealand some day, and urged servicemen to lose no time in embarking on the necessary training and study.

Colour TV on a popular scale is still a long way off, he considers. An interesting development which will eventually spell good news for N.Z. in the way of provision of programme material, is that of a means of recording vision and sound on tape.

After discussing TV interference problems, Mr. Lewis reviewed the recent Eurovision experiment, and indicated that, when the co-axial cable is completed between England and America, the U.S.A. will be included in the International hook-up. "In days to come," he said, "when N.Z. has a TV service, we too will be able to sit at home in a comfortable chair and actually see international transmissions. Until then, we must prepare for the day by making ourselves fully qualified by intense study so that we shall be fully equipped to handle this exciting new monster."

In view of Mr. Lewis's address, the Conference considered that the Association would have to press very hard to secure the Government assistance in establishment of an experimental station in Auckland. However, so that those servicemen already qualified should have a means of furthering their knowledge and extending it in a practical way, it was decided to continue with the project.

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(Continued from page 22.)

was an inexpensive, but very well-made British one, and added in the ext[illegible] upper register very cleanly and faithfully.

Before we close we would like to emphasise that we have tried the scheme with only one make and type of speaker. There is ample room for experiment, and it would be well worth while to undertake it, to find out how the various makes and models of small speakers perform, and which is the best to use for high-fidelity purposes. There is no doubt, in our minds at least, that for a total outlay of about £11/-/- (retail) one could construct a high-quality speaker system that would outperform some at least of the medium-to-high-priced single speakers on the market today and which will sound very little inferior to some of the multiple speaker systems that could be constructed only with the expenditure of three or four times the amount mentioned.

Record Talk

(Continued from page 40).

fine German recording of the B Minor Mass (PL 8063, 6 sides), and some rare Bruckner and Mahler. These are released under their English Vox numbers and so are presumably imported pressings, and all occupying two or more discs are housed in attractive albums. The Westminster records of the month are confined mostly to chamber music, which is always extremely well recorded on this particular label. The most interesting item, and one which will make knowledgeable fans rub their eyes, is a virtually unknown Trio in A Major by Brahms (WL 5098). It is well known that Brahms suppressed many of his early trios and quartets. Here is one that somehow escaped, and for admirers of this composer it will have a quite extraordinary interest. Less exciting, but very enjoyable and satisfying, are three trios by Boccherini, for the unusual combination of two violins and a cello, expertly played and recorded by Viennese artists on WL 5042.

On the lighter side, a collection of popular French songs sung by one Mira Jozelle (WL 3006) is decidedly worth investigation, as is all Westminster's light music series. And the roof-raising records by the Austrian "Deutschmeister Band" are well worth the sampling. New Zealanders are not, generally speaking, enamoured of the sound of a military band, but these Deutschmeister efforts have a dash and sparkle which sweep one off one's feet. There is a wonderful collection of Austrian marches on WL 3003 which can be taken as a fair sample.

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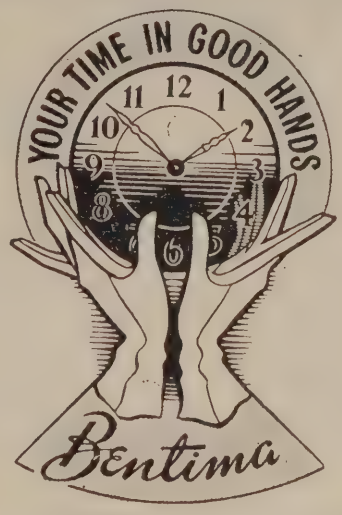

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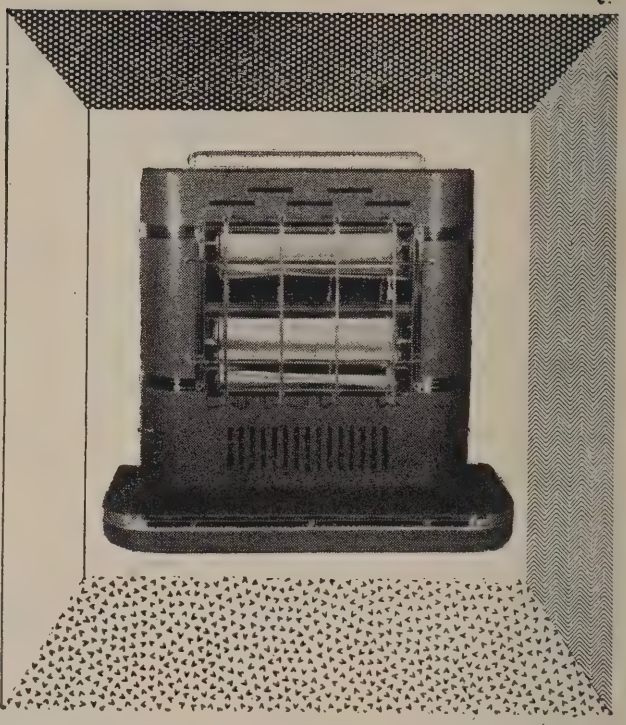

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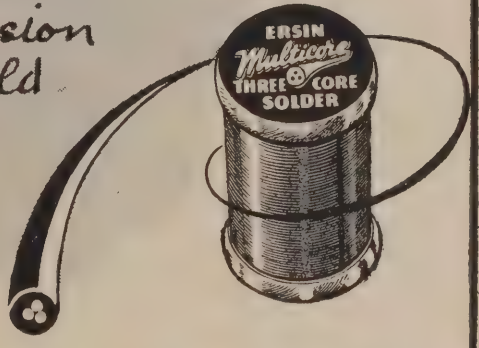

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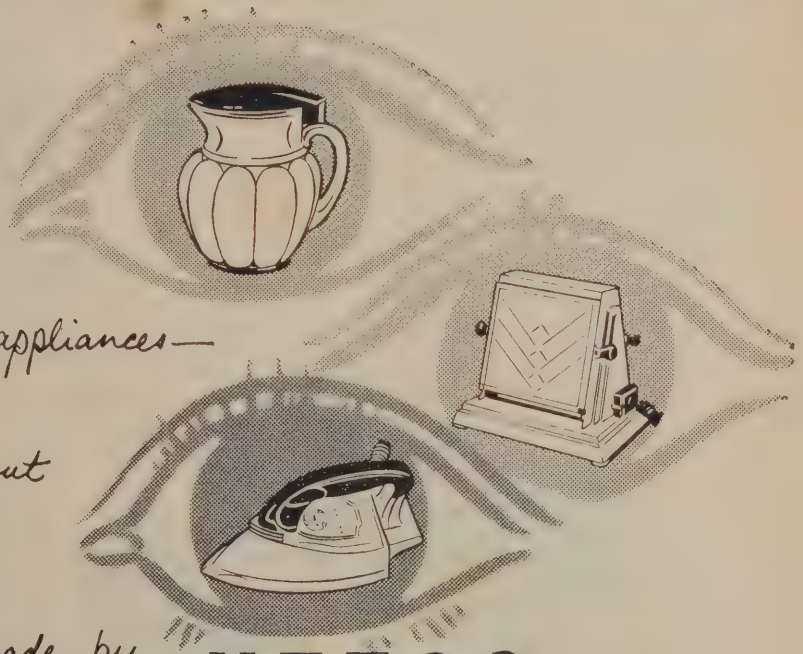

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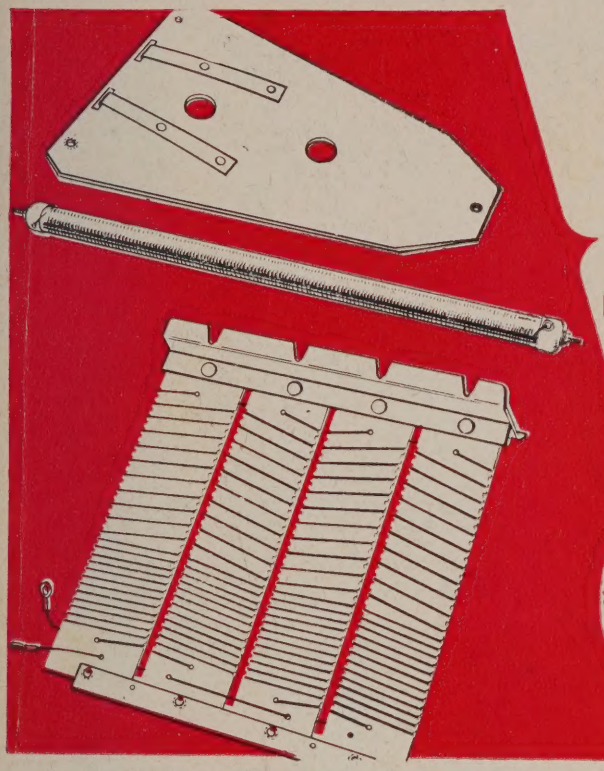

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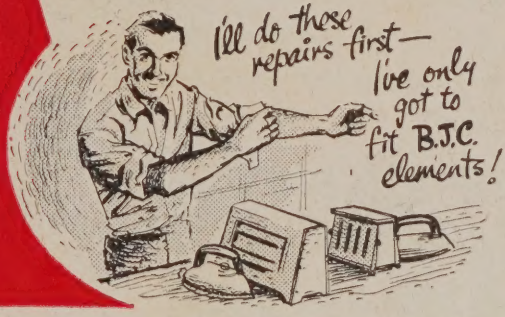
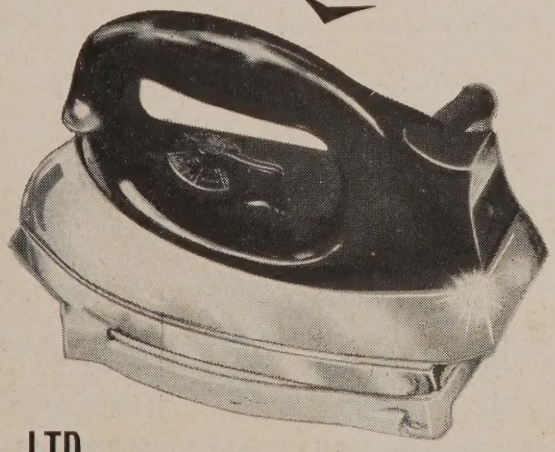
IRON TOASTER and ROD ELEMENTS



Manufactured by B. J. COCKSEDGE & CO. LTD., 82 KENT TERRACE, WELLINGTON. Phone 51-345.

It Catches the Eye of Passers-By



H. M. V. HEAT CONTROLLED IRON

Here's a sales prospect customers WILL LOOK OVER with more than casual interest and which retailers cannot OVERLOOK to stock! The H.M.V. No 5 Iron is a lightweight, cleverly designed iron that is thermostatically heat-controlled for complete safety, selecting at the turn of a dial just the right temperature for ironing rayon, silk, cotton, or linen. The bakelite handle is heat-resistant and heat-insulating . . . the soleplate is untarnishable . . . uniform ironing is assured . . . and ironing around and over buckles, buttons, pleats, etc., is made easy by the iron's shape. It's H.M.V., so it must be good—a good seller and a good product!

MAKE INQUIRIES NOW TO:

HIS MASTERS VOICE (N.Z.) LTD.

BOX 296, WELLINGTON

G.E.C. Electrical Gifts for Xmas!

Within the range of G.E.C. products are many that make useful and acceptable Xmas gifts. A selection has been listed in an attractive folder, supplies of which are available to electrical resellers on request.

CLOCKS • FIRES

WARMING PLATES • TORCHES

TORCH BATTERIES • HAIR DRYER • KETTLES

RADIO BATTERIES • DECORATION LIGHTS • TOASTERS • HANDLAMPS

HOME BROADCASTER • IRONS • FITTINGS • CLEANER • FLOOR POLISHER

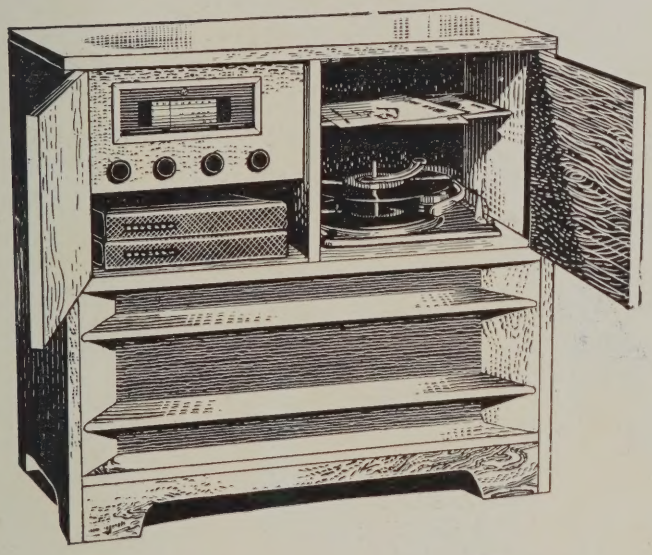
Sole New Zealand Representative

BRITISH GENERAL ELECTRIC CO. LTD.

WELLINGTON • AUCKLAND • CHRISTCHURCH • DUNEDIN

Who Else? ...

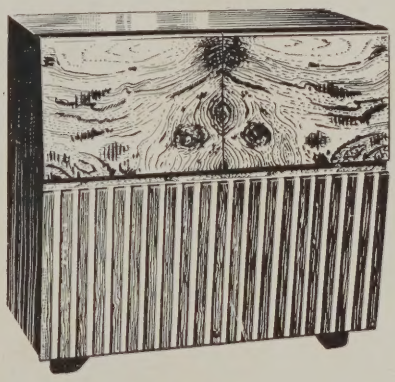
Who else but PYE could produce three such outstanding radiograms and market them at these sensationally low prices? Compare these PYE models with their competitors. Consider looks and tone, finish and reception, and, of course, price. Who else? NOBODY!



MODEL "BRG" (at left). A magnificent radiogram in light or dark oak, or highly polished walnut veneer. Pye craftsmanship ensures perfect reproduction from both radio and gramophone. Record player is Garrard 3-speed auto-changer.

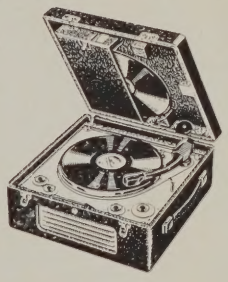
£69 10s. Oak

£76 Walnut



MODEL "69 RG" (above) a really superb instrument. The "69 RG" is an 8-valve push-pull Bandspread model with a 10 in. loudspeaker and Garrard 3-speed auto-changer. Cabinet in highly polished walnut.

£125



MODEL "R" (at right). The perfect portable radiogram—a strongly constructed wooden cabinet finished in dark blue art leather with dark blue fittings and light blue grille. 3-speed record player.

£38 10s.

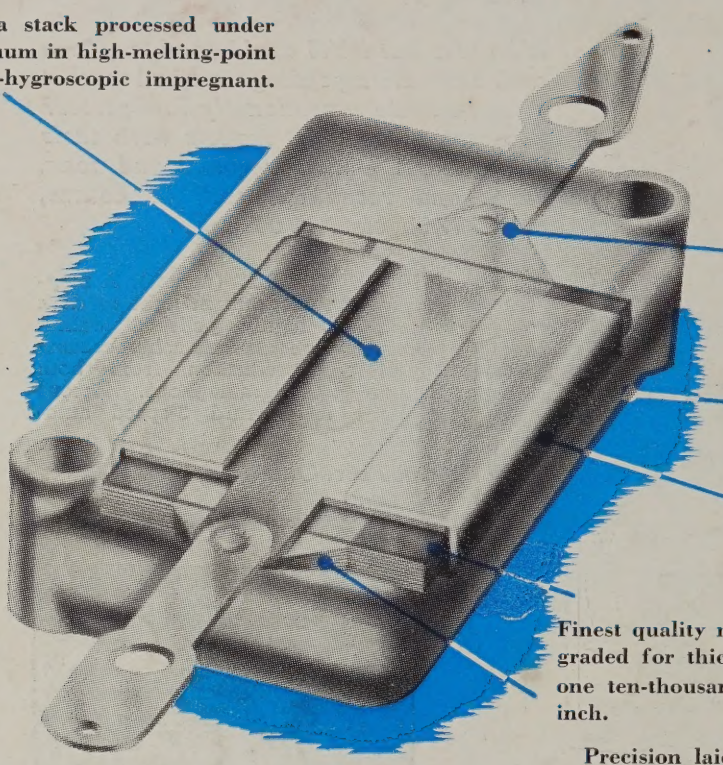
Radio and Television

Look for the distinctive PYE symbol at better radio dealers everywhere, or for the name of your nearest PYE Agent, write to:

PYE (NEW ZEALAND) LTD.

BOX 2839, AUCKLAND

Condenser leadership —from the inside!



Mica stack processed under vacuum in high-melting-point non-hygroscopic impregnant.

Hot tinned soldering tags, positively spot-welded to electrodes.

Moulding of high grade low-loss material.

Robust steel clamping plate to maintain stability.

Finest quality mica blades graded for thickness to one ten-thousandth of an inch.

Precision laid electrodes of heavy-gauge material providing ample current rating and mechanical strength.

The original T.C.C. 'M' Type moulded mica condensers—known the world over since the earliest days of radio—are now available in a wide range of capacities from .00005 μF. to .01 μF. and voltages from 350 D.C. to 2,500v. D.C. working. Their construction ensures low power factor and high insulation resistance.

Their ample current rating renders them ideally suitable for low power R.F. conditions such as are encountered in Signal Generators, Portable Transmitters, R.F. Measuring Instruments, etc.

As an alternative to the tag terminations shown, the complete range is available with wires $1\frac{1}{2}$ in. long.

Temperature range — 40°C. to + 71°C.

TCC

STACKED FOIL MOULDED MICA CONDENSERS

TURNBULL & JONES LTD.

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN HAMILTON PALMERSTON NORTH INVERCARGILL